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CLIMATOLOGICAL MEMORANDUM No. 73

MAPS OF MEAN AND EXTREME TEMPERATURE OVER THE UNITED KINGDOM 1941-1970

Climatological Services (Met. O. 3)

August 1975

Related Climatological Memoranda

No 51A	1941–70 Averages of Barometric Pressure at 09 GMT.
No 72	Maps of Average Duration of Bright Sunshine over the United Kingdom 1941–70.
No 74	Maps of Mean Number of Days of Snow over the United Kingdom, 1941–70.
No 75	Maps of Mean Vapour Pressure and Frequencies of High Relative Humidity over the United Kingdom.

CLIMATOLOGICAL MEMORANDUM NO 73

MAPS OF MEAN AND EXTREME TEMPERATURE OVER THE UNITED KINGDOM 1941-70

INTRODUCTION

The maps presented in this memorandum are based mainly on observations of screen temperatures from about 250 station for the 30 years 1941-70. For some stations data for shorter periods or broken records have been weighted to give estimated values for the full 30-year period. Details of the methods used are given elsewhere[1] along with averages and extremes at individual stations. Full details of exposure of instruments and observational methods may be found in the "Observer's Handbook"[2]. Descriptions of the maps are given below. A number of graphs are also presented to show typical diurnal, annual and year-to-year variations in temperature.

DESCRIPTION OF MAPS

1. Mean daily maximum temperature, mean daily minimum temperature, and mean daily temperature for each month and the year 1941-70. (Figures 1.1 to 1.39

Maximum and minimum temperatures are read and re-set each morning at 09 GMT At a number of stations the maximum and minimum thermometers are also read and re-set in the evening, usually at 21 GMT; these stations do not then record 24-hour extremes but 'day' maximum and 'night' minimum. An investigation of temperatures at 38 stations over the period 1957-70 has shown the following average differences:

Table 1. Mean difference between day/night and 24-hour extreme temperatures in degrees Celsius

A = 24-hour maximum temperature B = 24-hour minimum temperature

C = 09-21h 'day' maximum temperature D = 21-09h 'night' minimum temperature

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
A-C	0.3	0.2	0.1	0.1	0,1	0.1	< 0.1	< 0.1	0.1	0.1	0.2	0.4
D-B	0.7	0.5	0.3	0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	0.3	0.6	0.7

Before analysing the maps of mean daily maximum and minimum temperature, these corrections have been applied to the temperature at those stations reporting 'day' and 'night' extremes to make the values comparable with those from the majority of stations which recorded only 24-hour extremes.

In order to prevent these maps being as complex as topographic maps, the station temperatures were adjusted to mean sea level before the maps were analysed. Maximum temperatures were increased by 0.7 deg C for each 100 metres above sea level and minimum temperatures by 0.5 deg C for each 100 metres above sea level. These values were chosen as suitable national and seasonal averages after study of temperature change with height over the whole United Kingdom. Therefore, to estimate mean maximum or minimum temperature at any particular site of known altitude from the maps, 0.7 deg C or 0.5 deg C, respectively, should be subtracted from the appropriate map value for each 100m above sea level. It should be noted however that an estimate derived in this way would apply only to a 'typical' open site. The mean minimum temperature in a well-sheltered frost hollow could be as much as 1.5 deg C lower, and for an exposed windy site about 0.5 deg C higher, than that estimated from the maps. Also, to allow for low maximum temperatures on hill tops (particularly in the warmer months in England) it is suggested that a lapse of 0.9 deg C per 100m be used for the estimation of maxima for sites higher than 400m above mean sea level.

Temperatures at urban sites (particularly minima in winter) tend to be somewhat higher than those for nearby rural sites. In the analysis of the maps less weight has been given to these urban observations and the maps can be taken to represent open country conditions. An exception has been made in the London area where the map analysis has followed the plotted urban values, since the size of the conurbation is sufficiently large to enable the temperature pattern to be adequately defined on the chosen map scale.

The monthly mean daily temperature is obtained from the arithmetic mean of the mean daily maximum and mean daily minimum for the month. This is a close approximation to the mean of 24 hourly readings, being on average about 0.3 deg C lower in the winter months and about 0.2 deg C higher in the summer months. These values were obtained from a comparison between the mean of 24 hourly temperatures and the mean of the 09h-09h maximum and minimum temperatures at 14 stations over the period 1957 to 1971.

The maps of mean daily temperature were constructed by 'gridding' (i.e. graphically adding) the appropriate maps of mean daily maximum and minimum temperatures and then checking the isopleth positions against plotted values of mean temperature. The altitude correction for maps of mean temperature (figures 1.27 to 1.39) is 0.6 deg C per 100m above mean sea level.

Table 2 gives mean daily temperatures at a selection of places for different averaging periods since 1901. The 1941-1970 period shows the continuing trend towards lower temperatures in January and February and higher values in September and October. The rise in temperature in the summer months in the earlier periods is not continued in the latest period.

2. Difference between the highest monthly mean daily ~~maximum~~ temperature and the lowest monthly mean daily ~~minimum~~ temperature, 1941-70 (Figure 2.1)

This difference can be considered as a measure of the range of temperature. Values at those stations recording 'day' and 'night' extremes have been adjusted to a common 24-hour standard as described above. No corrections for altitude have been applied.

3. Mean annual maximum and minimum temperature 1941-70 (Figures 3.1 and 3.2)

These maps are constructed from the highest and lowest temperatures recorded in each year. The relationship of these temperatures with altitude was investigated and as a result an addition of 1.0 deg C for each 100m above mean sea level has been applied to the maximum temperatures. This broadly fitted all areas of the United Kingdom. The variation with altitude of minimum temperatures was much more variable geographically and the addition of 0.5 deg C for each 100m above sea level (ie as for the mean daily minima) was chosen as the best figure for national application. Observations from urban sites (except those in the London area) and from known frost hollows have not been followed in the analyses of these maps.

4. Annual maximum and minimum temperature that can be expected on average only once in 50 years (based on data 1941-70) (Figures 4.1 and 4.2)

Estimates of the extreme temperatures likely to be reached or exceeded on average only once in 50 years have been made by analysis of the annual temperature extremes over the 30 year period 1941-70. The statistical method used is described elsewhere[3]. Station values have been reduced to mean sea level by adding 1.0 deg C per 100m and 0.5 deg C per 100m for maximum and minimum temperatures respectively.

5. Mean annual number of days with minimum temperature less than 0.0 deg C and with maximum temperature more than 25.0 deg C, 1956-70 (figures 5.1 and 5.2)

The maps of mean annual number of days with air frost (minimum temperature below 0.0 deg C) and with maximum temperature above 25.0 deg C have not been corrected to mean sea level. Especially in areas of complex topography the density of observing stations and the scale of the maps used allow only a general picture to be presented and significant local differences from the map values are to be expected.

DESCRIPTION OF GRAPHS

Figure 6.1 shows the variation from year to year of mean daily maximum and mean daily minimum temperature in the four mid-season months during the period 1941-70, at Mount Batten (Plymouth), Boscombe Down (Wiltshire), Wick (Caithness) and Eskdalemuir (Dumfriesshire). Notable features of these graphs are the trends towards lower temperatures in April and higher temperatures in October during this period and the extremely low temperatures of January 1963, especially in the south.

Figure 6.2 shows the diurnal variation of temperature at Mount Batten, London (Heathrow) Airport, and Eskdalemuir during the period 1957-70. In figure 6.3 the annual variation of mean daily maximum, mean daily minimum and mean daily temperature (1941-70) is shown for Mount Batten, Rothamsted (Hertfordshire) and Eskdalemuir. Also included are the extreme temperatures each month.

The variation in annual mean temperature at Oxford during the period 1900 to 1973 is shown in figure 6.4.

REFERENCES

1. Averages of Temperature over the United Kingdom 1941-1970 H.M.S.O. (to be published).
2. Observer's Handbook H.M.S.O. 1969.
3. Hopkins, J S and Whyte, K W; Extreme Temperatures over the United Kingdom for Design Purposes Met. Mag. 104. April 1975.

Table 2 Comparison of mean daily temperature for 5 30-year periods

Place / Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Braemar													
1901-1930	1.6	1.4	2.4	4.6	7.9	10.8	12.6	11.8	9.7	6.6	3.1	1.7	6.2
1911-1940	1.4	1.6	2.5	4.7	8.1	10.9	12.9	12.3	9.7	6.4	3.2	1.7	6.3
1921-1950	1.1	1.4	2.9	5.0	7.9	11.1	13.1	12.3	9.9	6.7	3.3	1.9	6.4
1931-1960	0.6	1.0	2.8	5.2	8.3	11.4	13.1	12.6	10.2	7.0	3.8	2.0	6.5
1941-1970	0.4	0.5	2.7	5.2	8.2	11.5	12.7	12.3	10.3	7.5	3.4	1.7	6.4
Morpeth (Cockle Park)													
1901-1930	3.2	3.2	4.3	6.1	9.1	11.8	13.9	13.6	11.4	8.5	5.1	3.6	7.8
1911-1940	3.3	3.5	4.3	6.3	9.3	12.2	14.2	13.9	11.6	8.5	5.4	3.8	8.0
1921-1950	3.1	3.3	4.8	6.7	9.2	12.4	14.6	14.0	12.1	8.8	5.5	3.8	8.2
1931-1960	2.6	3.0	4.7	6.9	9.4	12.5	14.5	14.1	12.1	9.0	5.8	4.0	8.2
1941-1970	2.6	2.7	4.5	6.9	9.3	12.5	14.1	13.9	12.3	9.4	5.5	3.7	8.1
Sheffield													
1901-1930	4.3	4.2	5.4	7.5	11.1	13.6	15.7	15.3	13.1	9.8	6.2	4.6	9.2
1911-1940	4.2	4.2	5.5	7.6	11.3	14.0	15.9	15.7	13.4	9.7	6.4	4.7	9.4
1921-1950	4.0	4.0	5.8	8.1	11.1	14.3	16.4	15.8	13.7	10.1	6.6	4.7	9.5
1931-1960	3.6	3.8	5.7	8.4	11.3	14.5	16.3	16.0	13.8	10.2	6.9	4.9	9.6
1941-1970	3.4	3.5	5.5	8.3	11.3	14.5	16.0	15.7	13.9	10.7	6.6	4.6	9.5
Oxford													
1901-1930	4.4	4.6	6.1	8.2	12.1	14.4	16.6	16.0	13.7	10.3	6.2	4.8	9.8
1911-1940	4.5	4.6	6.2	8.4	12.2	14.8	16.7	16.5	14.0	10.1	6.5	4.7	9.9
1921-1950	4.2	4.5	6.4	8.9	11.9	15.1	17.1	16.7	14.4	10.4	6.7	4.6	10.1
1931-1960	3.7	4.2	6.4	9.1	12.0	15.3	17.1	16.9	14.4	10.5	7.0	4.9	10.1
1941-1970	3.5	4.0	6.2	9.1	12.1	15.3	16.9	16.5	14.4	10.9	6.9	4.6	10.1
Eastbourne													
1901-1930	5.4	5.2	6.4	8.3	11.8	14.1	16.2	16.4	14.6	11.6	7.7	6.2	10.3
1911-1940	5.4	5.3	6.4	8.5	12.0	14.3	16.5	16.8	14.9	11.4	8.0	6.0	10.5
1921-1950	5.2	5.1	6.5	8.9	11.8	14.8	16.8	16.9	15.2	11.8	8.1	5.7	10.6
1931-1960	4.7	4.6	6.4	9.0	12.0	14.9	16.8	17.1	15.3	11.9	8.3	6.0	10.6
1941-1970	4.5	4.5	6.3	8.8	11.8	14.7	16.6	16.8	15.3	12.3	8.2	5.9	10.5

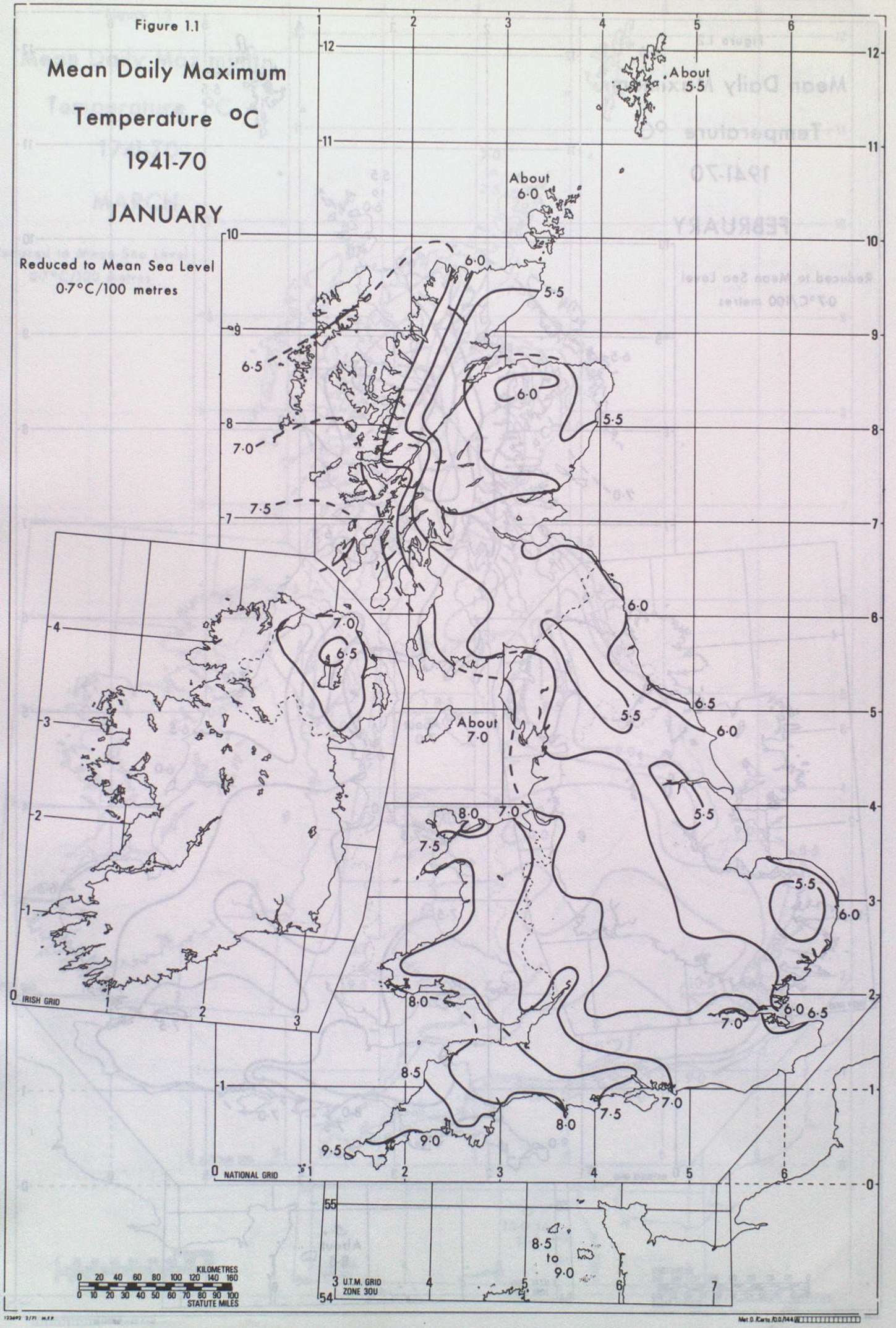


Figure 1.1
Mean Daily Maximum Temperature °C
1941-70
JANUARY
Reduced to Mean Sea Level
0·7°C/100 metres
About 5·5
About 6·0
About 7·0
6·0
5·5
6·5
7·0
7·5
8·0
8·5
9·0
9·5
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
8·5 to 9·0
KILOMETRES
0 20 40 60 80 100 120 140 160
STATUTE MILES
0 10 20 30 40 50 60 70 80 90 100

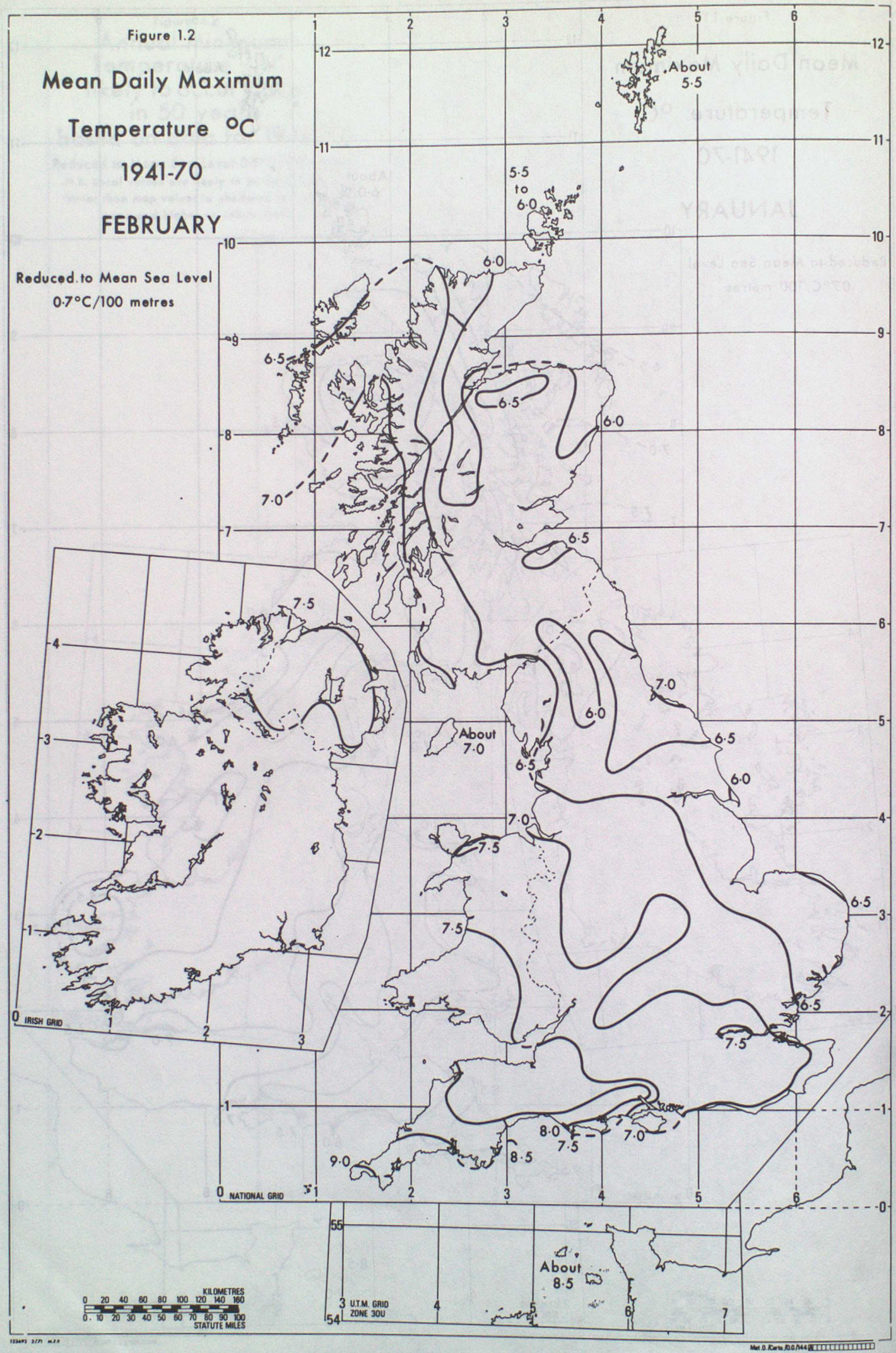
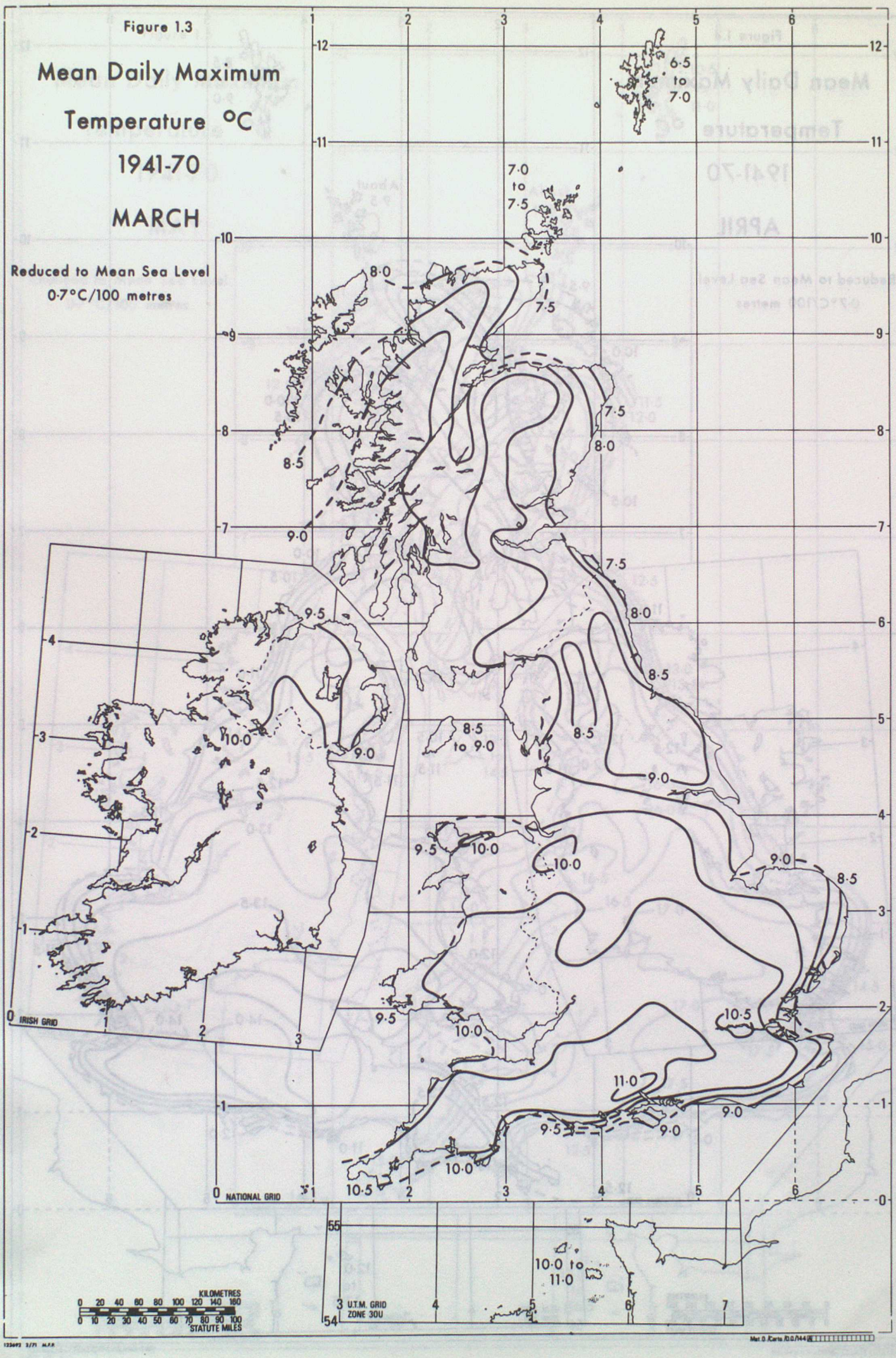


Figure 1.2
Mean Daily Maximum Temperature °C
1941-70
FEBRUARY
Reduced to Mean Sea Level
0·7°C/100 metres
About 5·5
5·5 to 6·0
6·0
6·5
7·0
7·5
About 7·0
8·0
8·5
9·0
About 8·5
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
0 10 20 30 40 50 60 70 80 90 100
STATUTE MILES

Figure 1.3

Mean Daily Maximum Temperature °C 1941-70 MARCH

Reduced to Mean Sea Level
0·7°C/100 metres



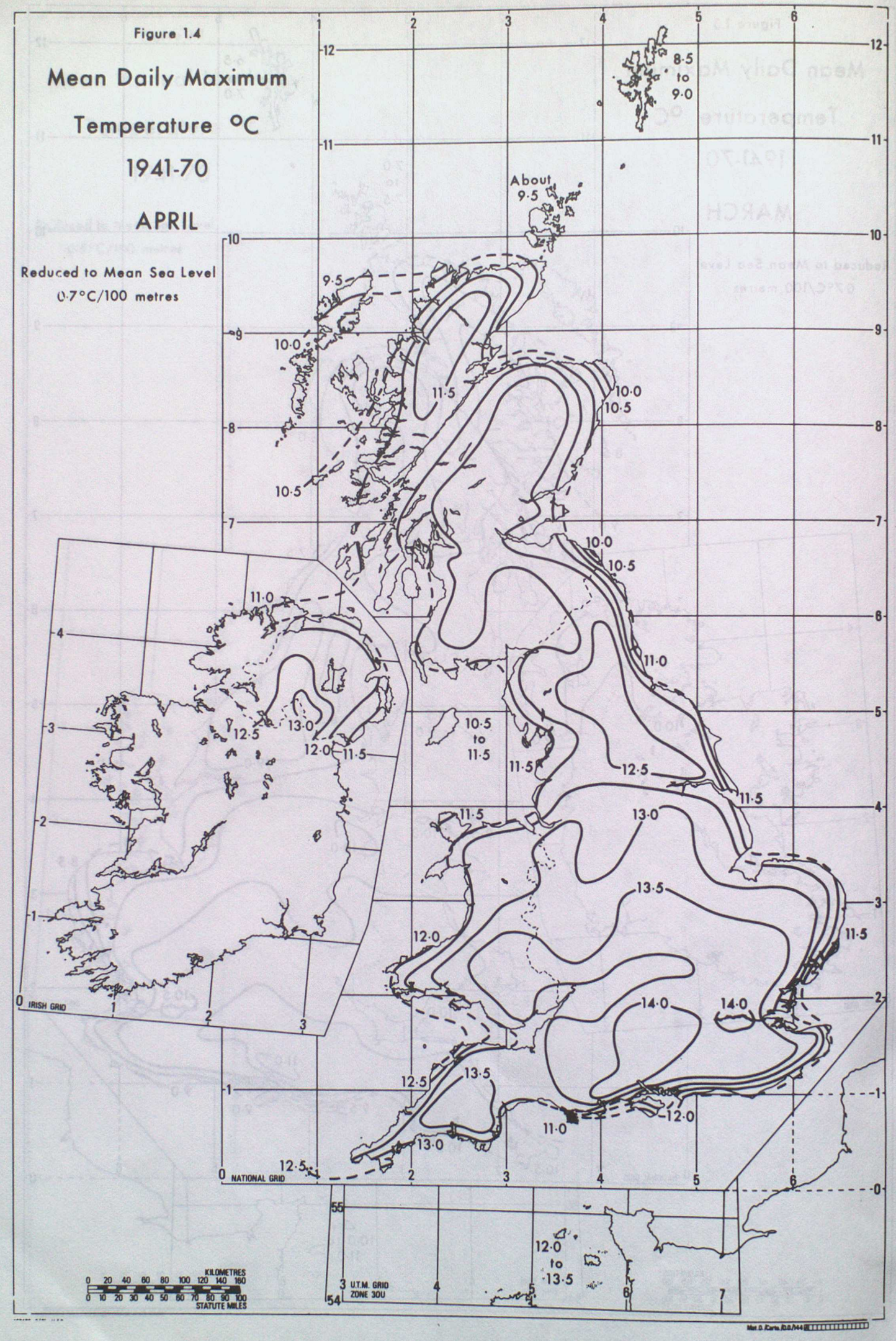
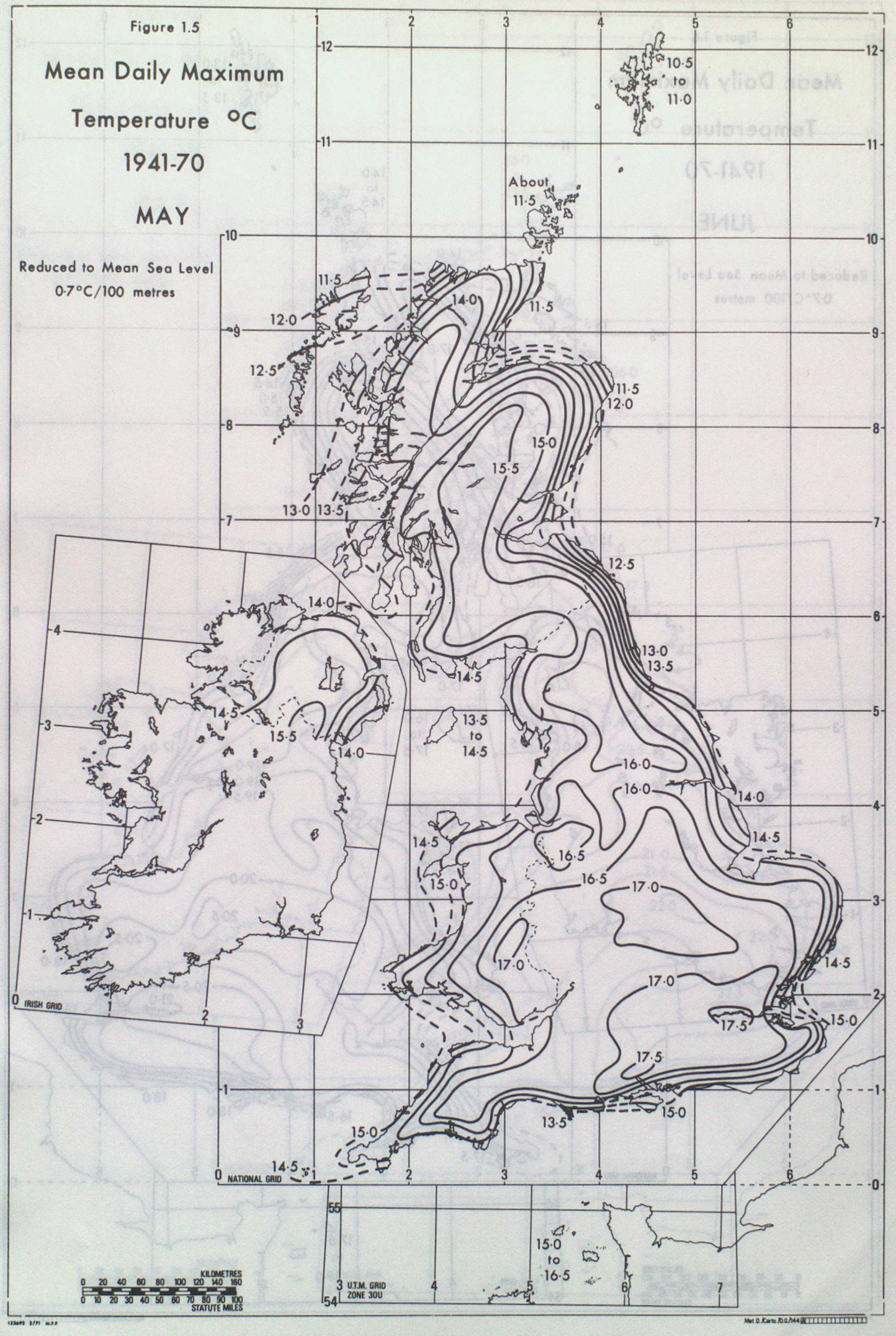


Figure 1.4
Mean Daily Maximum Temperature °C
1941-70
APRIL
Reduced to Mean Sea Level
0·7°C/100 metres
8·5 to 9·0
About 9·5
9·5
10·0
10·5
11·0
11·5
12·0
12·5
13·0
13·5
14·0
10·5 to 11·5
12·0 to 13·5
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
STATUTE MILES
0 10 20 30 40 50 60 70 80 90 100

Figure 1.5

Mean Daily Maximum Temperature °C 1941-70 MAY

Reduced to Mean Sea Level
0·7°C/100 metres



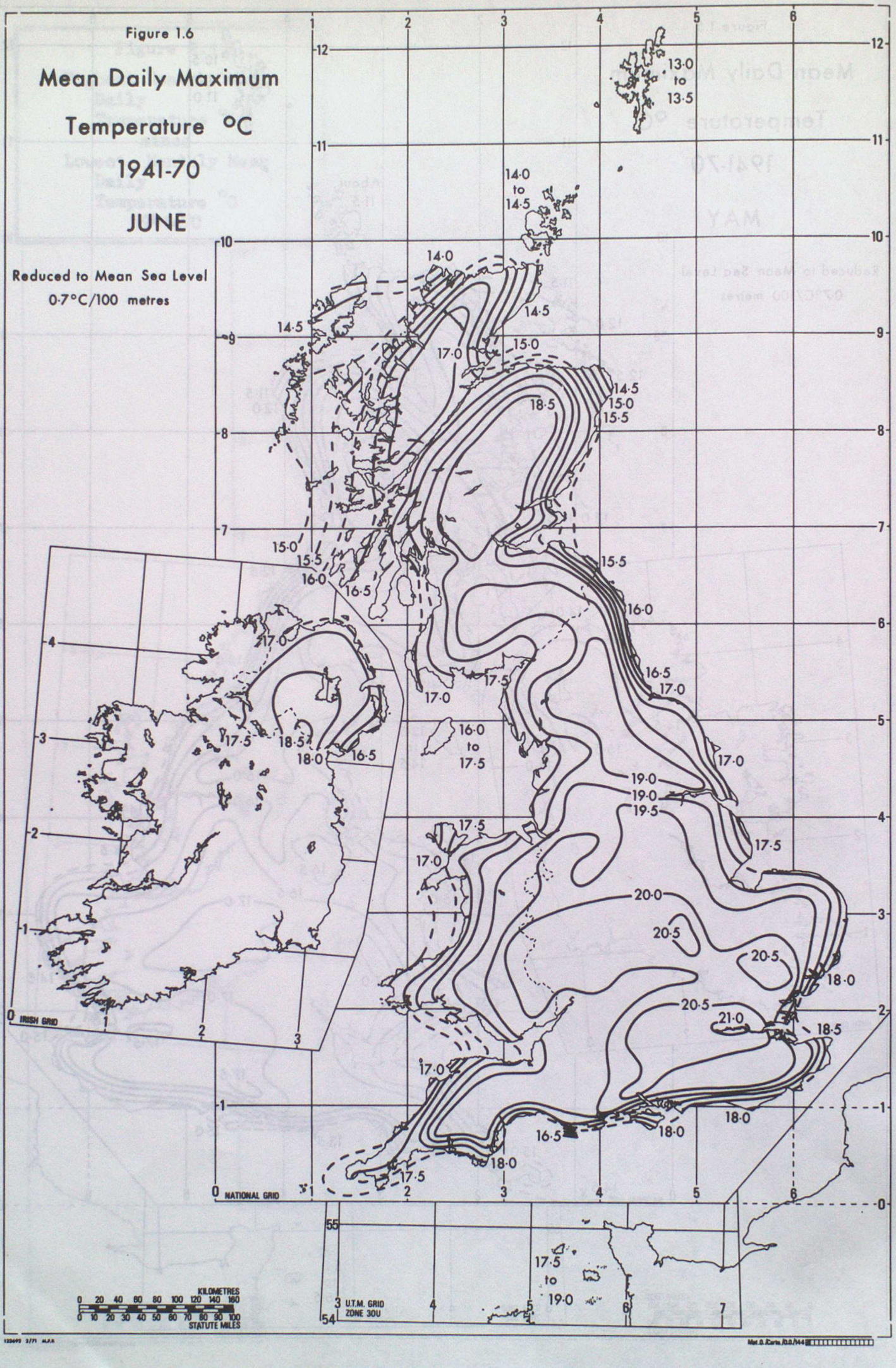
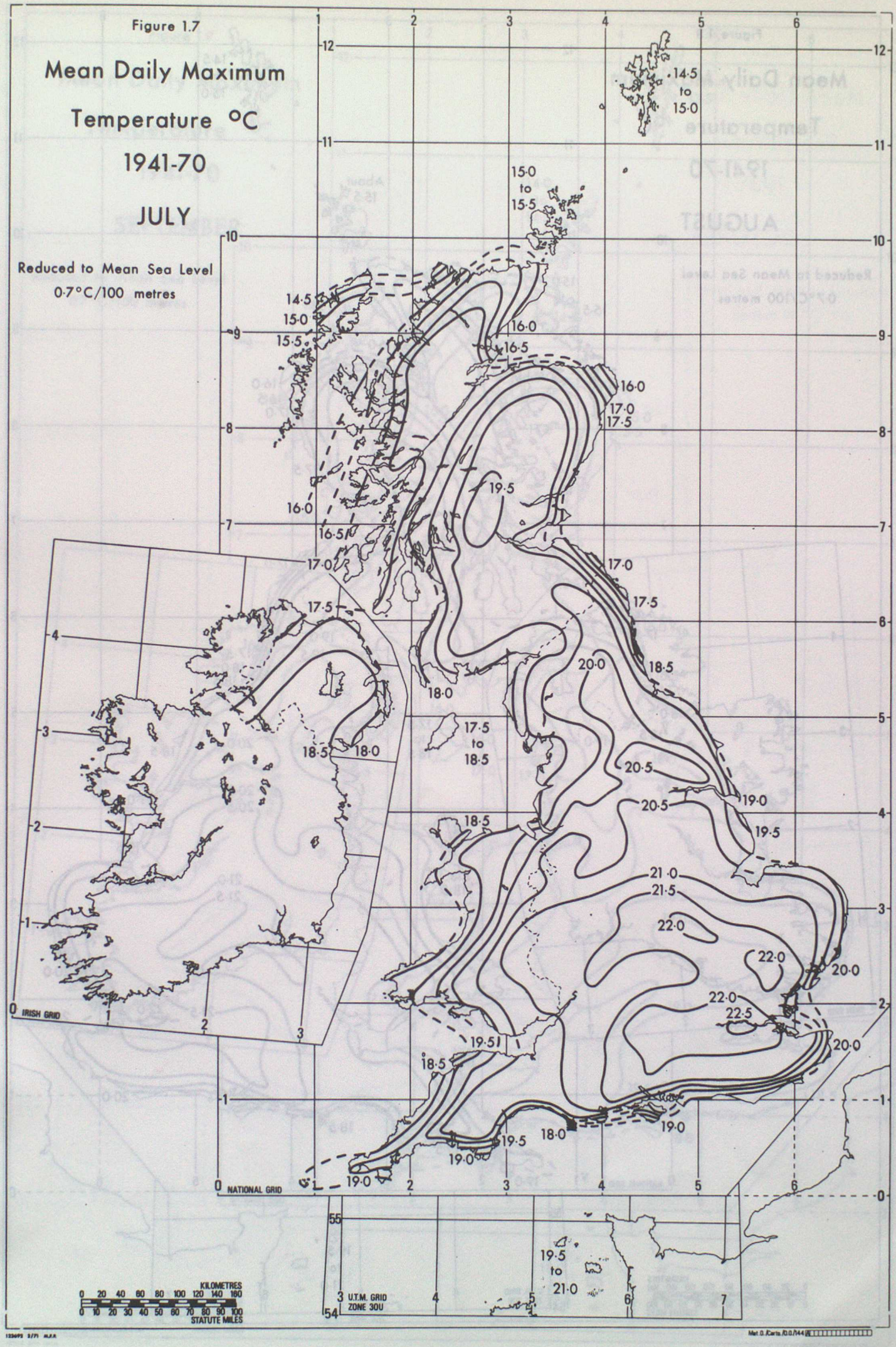


Figure 1.6
Mean Daily Maximum Temperature °C
1941-70
JUNE
Reduced to Mean Sea Level
0·7°C/100 metres
13·0 to 13·5
14·0 to 14·5
16·0 to 17·5
17·5 to 19·0
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
STATUTE MILES

Figure 1.7

Mean Daily Maximum Temperature °C 1941-70 JULY

Reduced to Mean Sea Level
0·7°C/100 metres



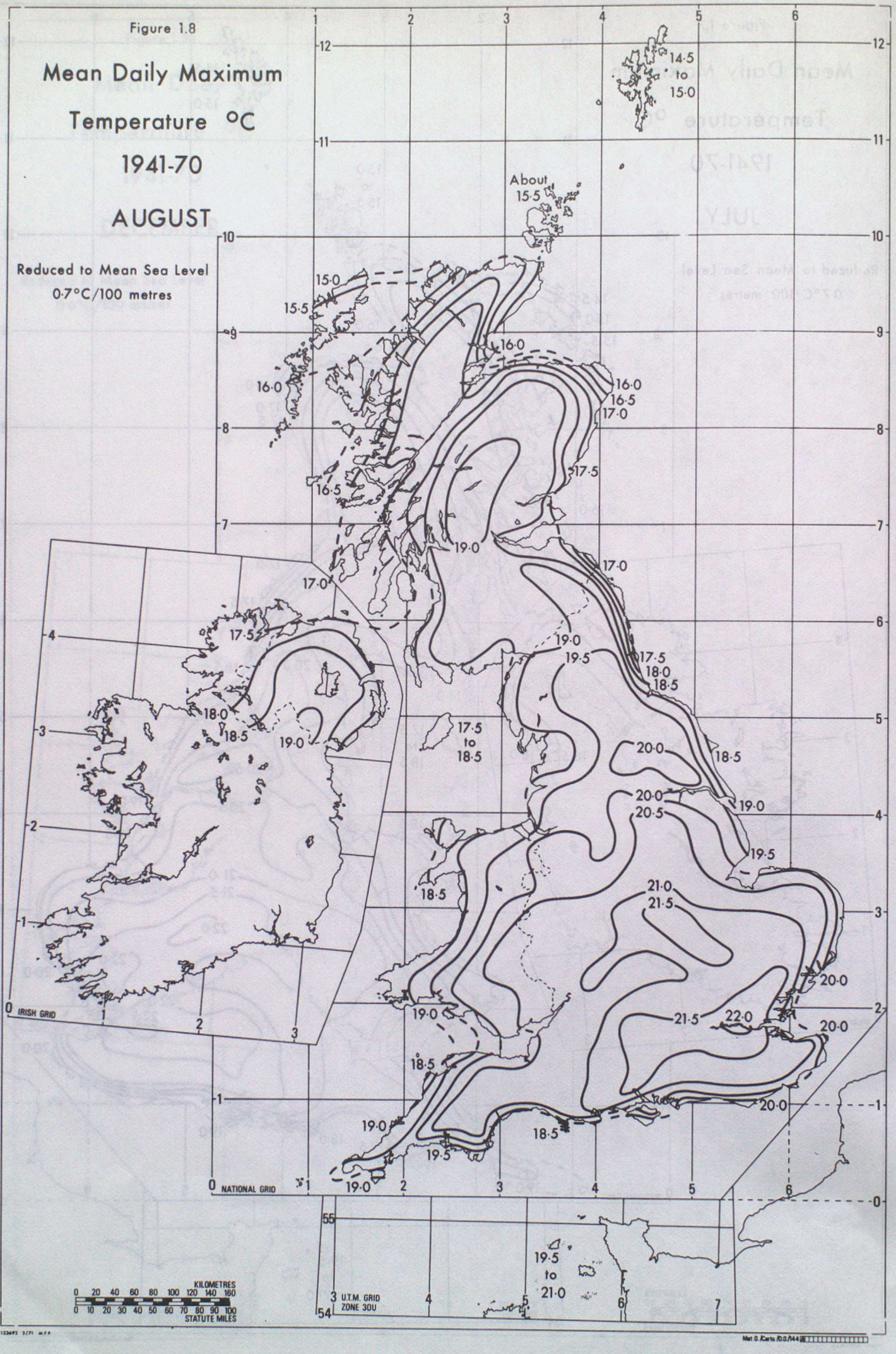


Figure 1.8
Mean Daily Maximum Temperature °C
1941-70
AUGUST
Reduced to Mean Sea Level
0·7°C/100 metres
14·5 to 15·0
About 15·5
15·0
15·5
16·0
16·5
17·0
17·5
18·0
18·5
19·0
19·5
20·0
20·5
21·0
21·5
22·0
17·5 to 18·5
19·5 to 21·0
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
0 10 20 30 40 50 60 70 80 90 100
STATUTE MILES

Figure 1.9

Mean Daily Maximum Temperature °C 1941-70 SEPTEMBER

Reduced to Mean Sea Level
0·7°C/100 metres

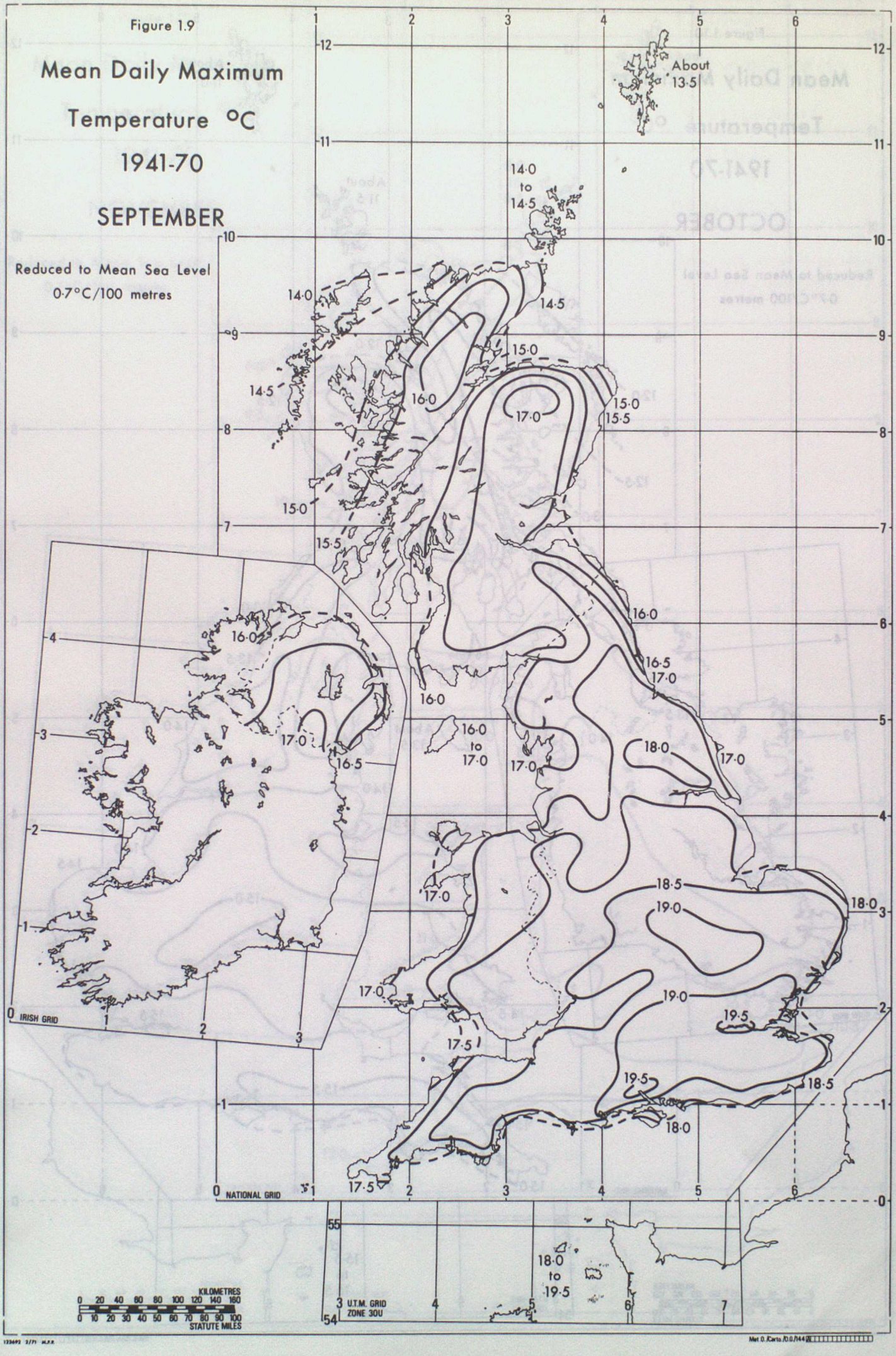


Figure 1.10

Mean Daily Maximum Temperature °C 1941-70 OCTOBER

Reduced to Mean Sea Level
0·7°C/100 metres

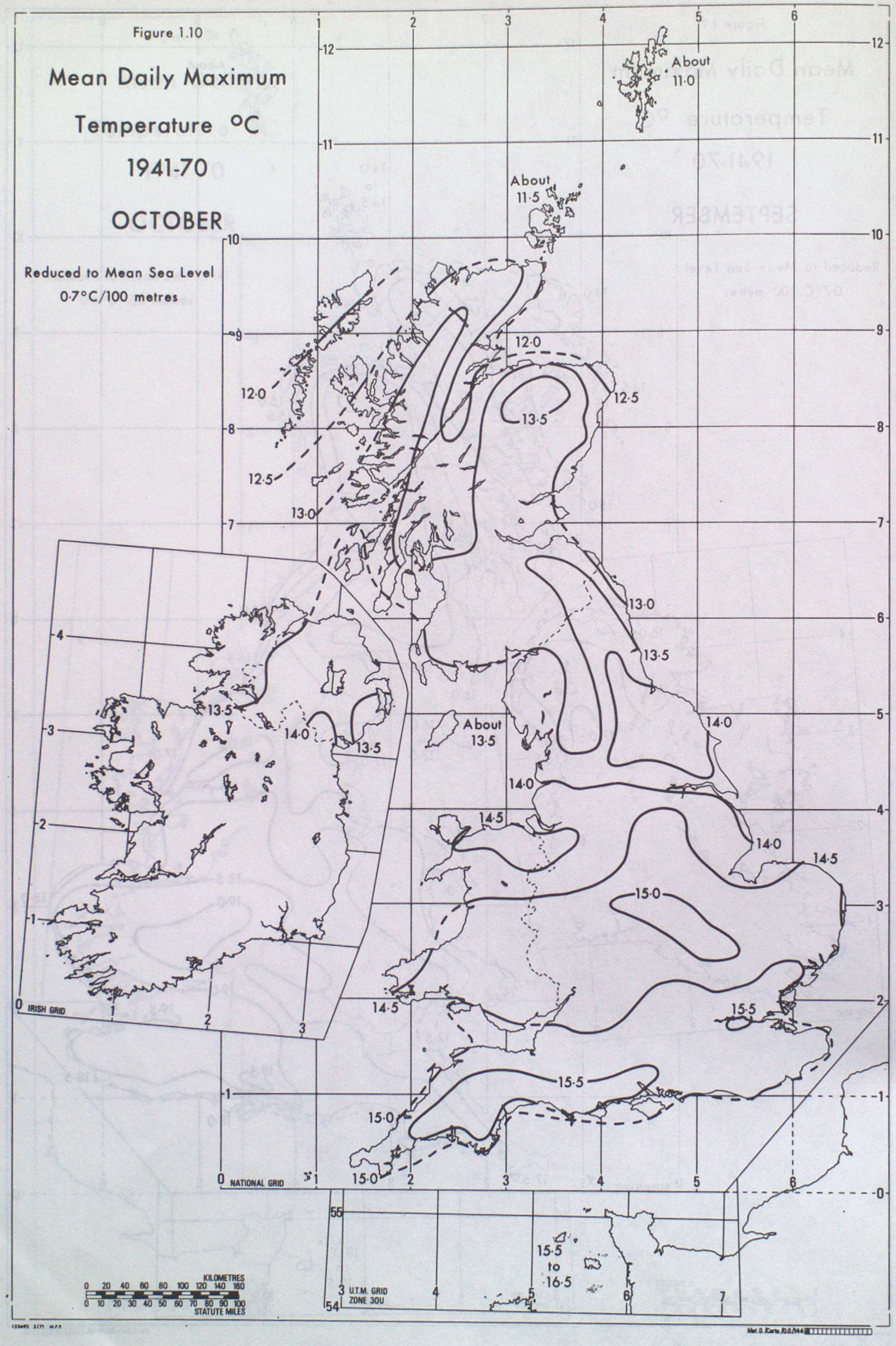


Figure 1.11

Mean Daily Maximum Temperature °C 1941-70 NOVEMBER

Reduced to Mean Sea Level
0·7°C/100 metres

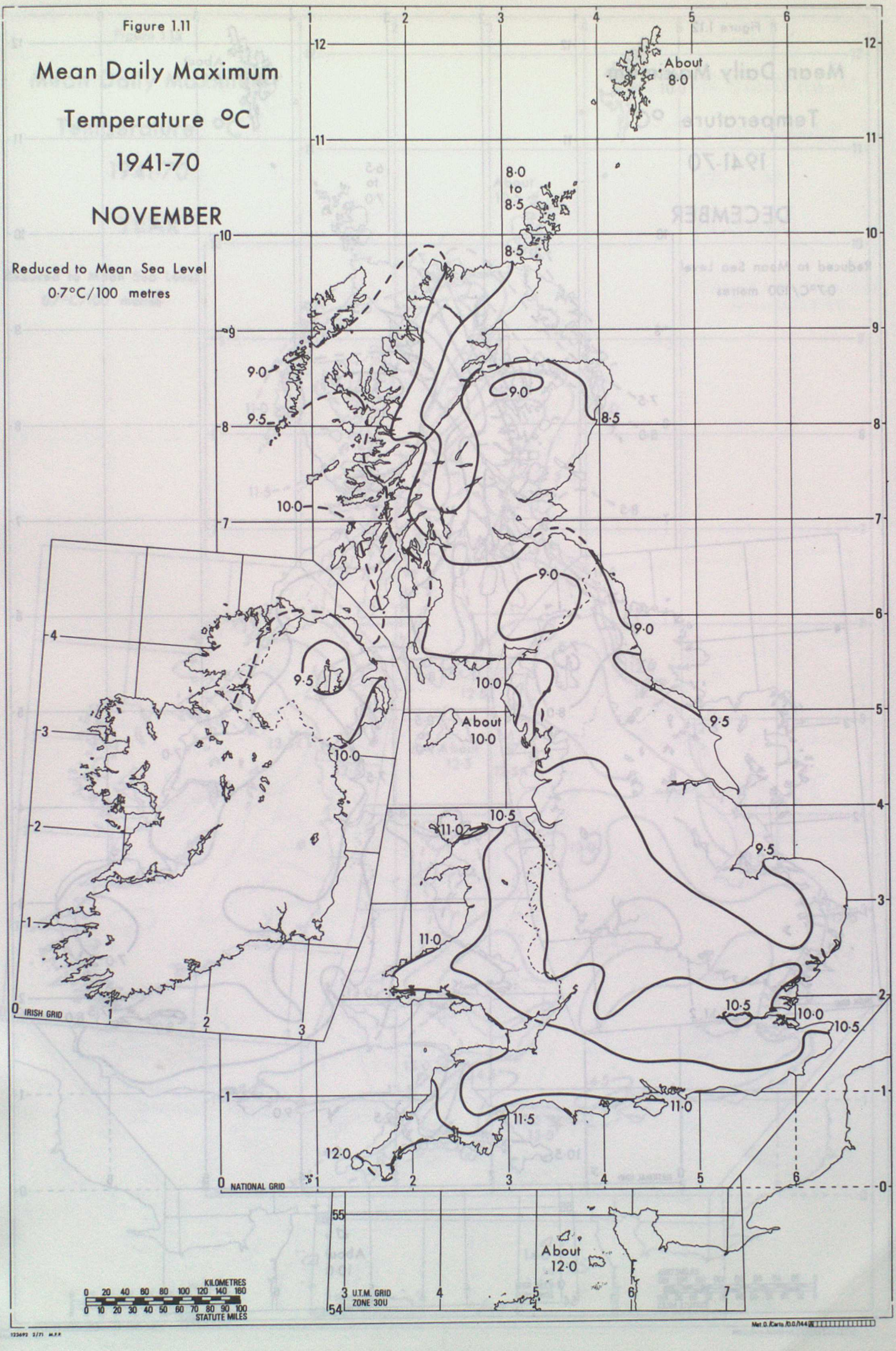


Figure 1.12

Mean Daily Maximum Temperature °C 1941-70 DECEMBER

Reduced to Mean Sea Level
0·7°C/100 metres

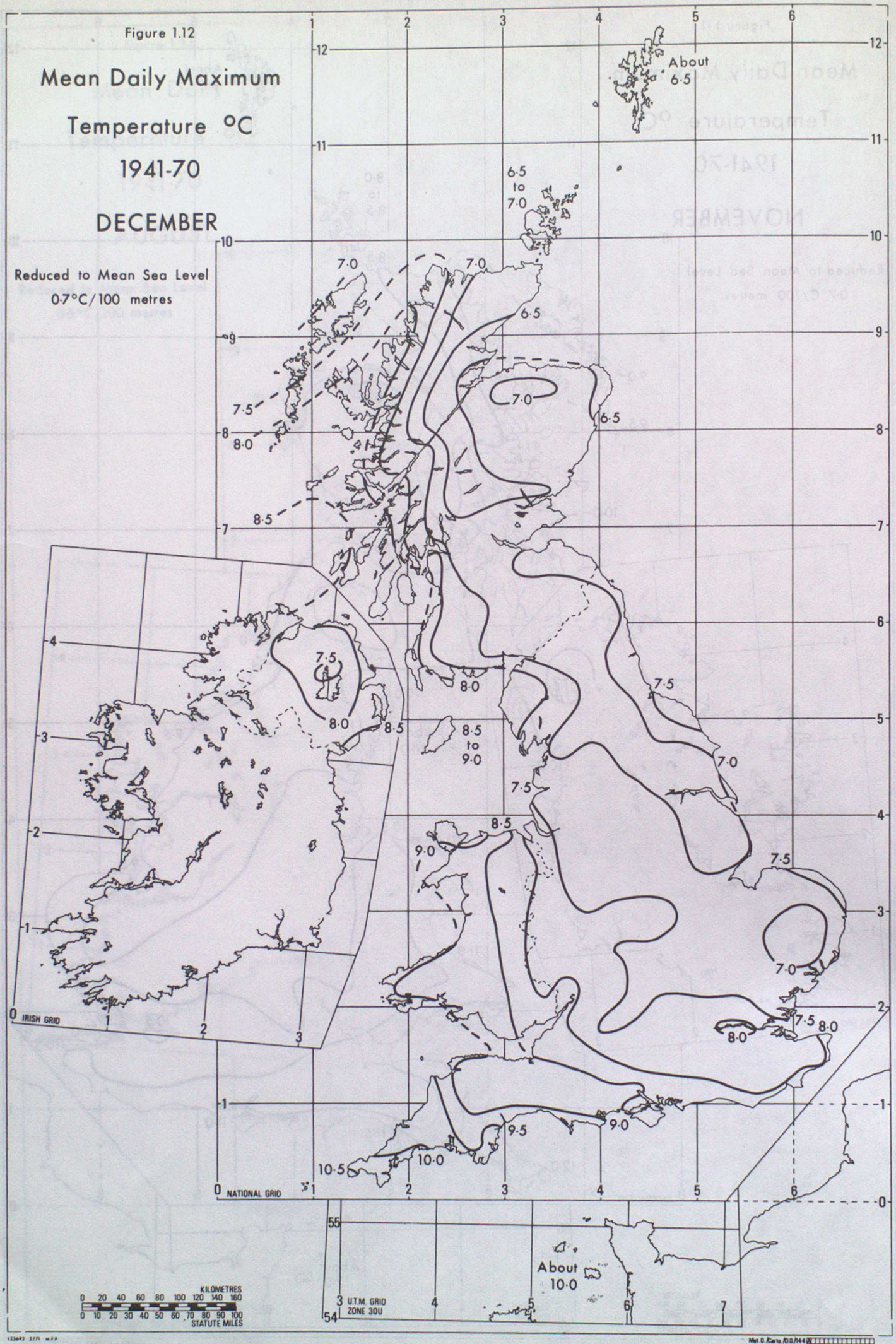
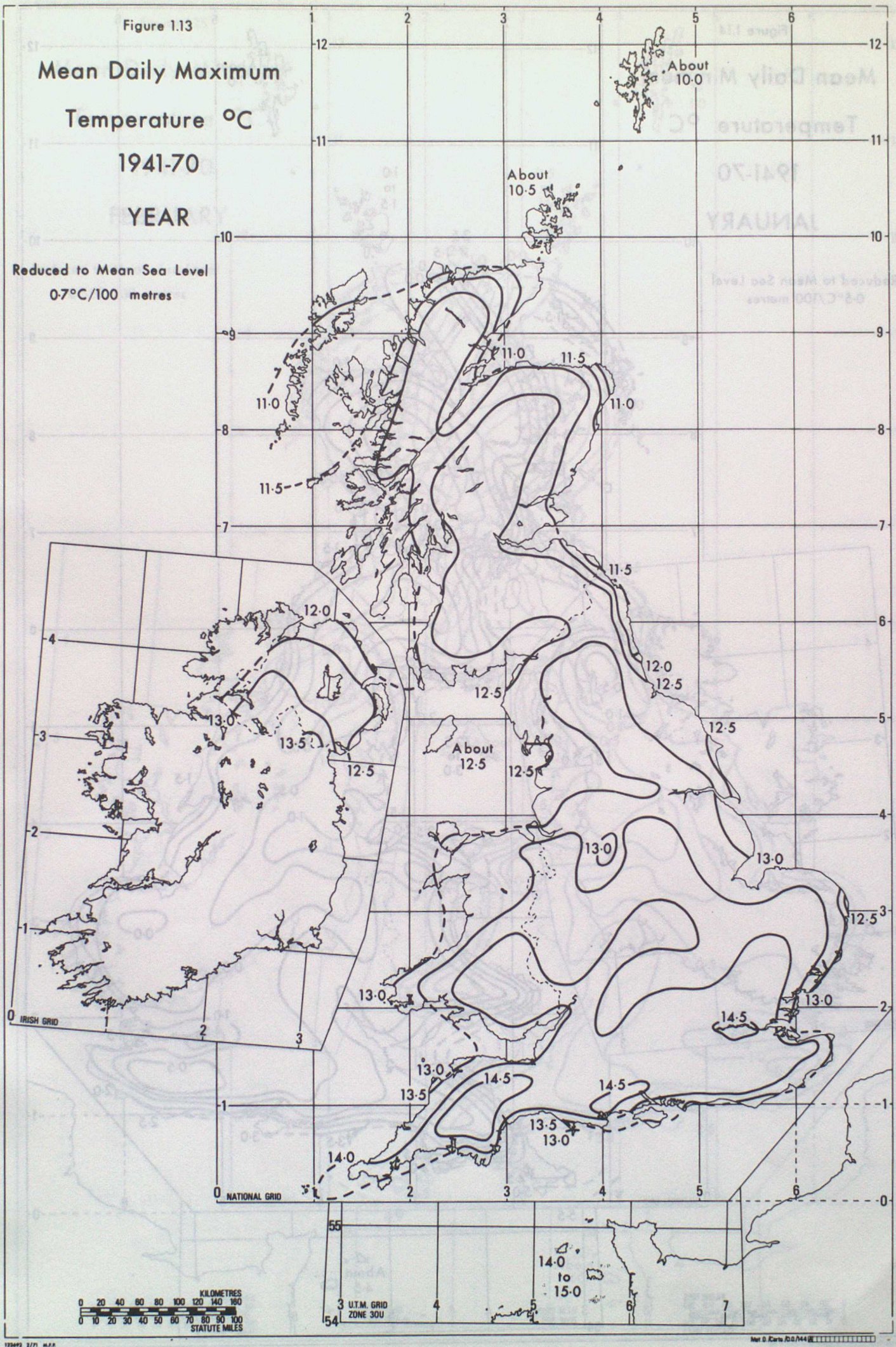


Figure 1.13

Mean Daily Maximum Temperature °C 1941-70 YEAR

Reduced to Mean Sea Level
0·7°C/100 metres



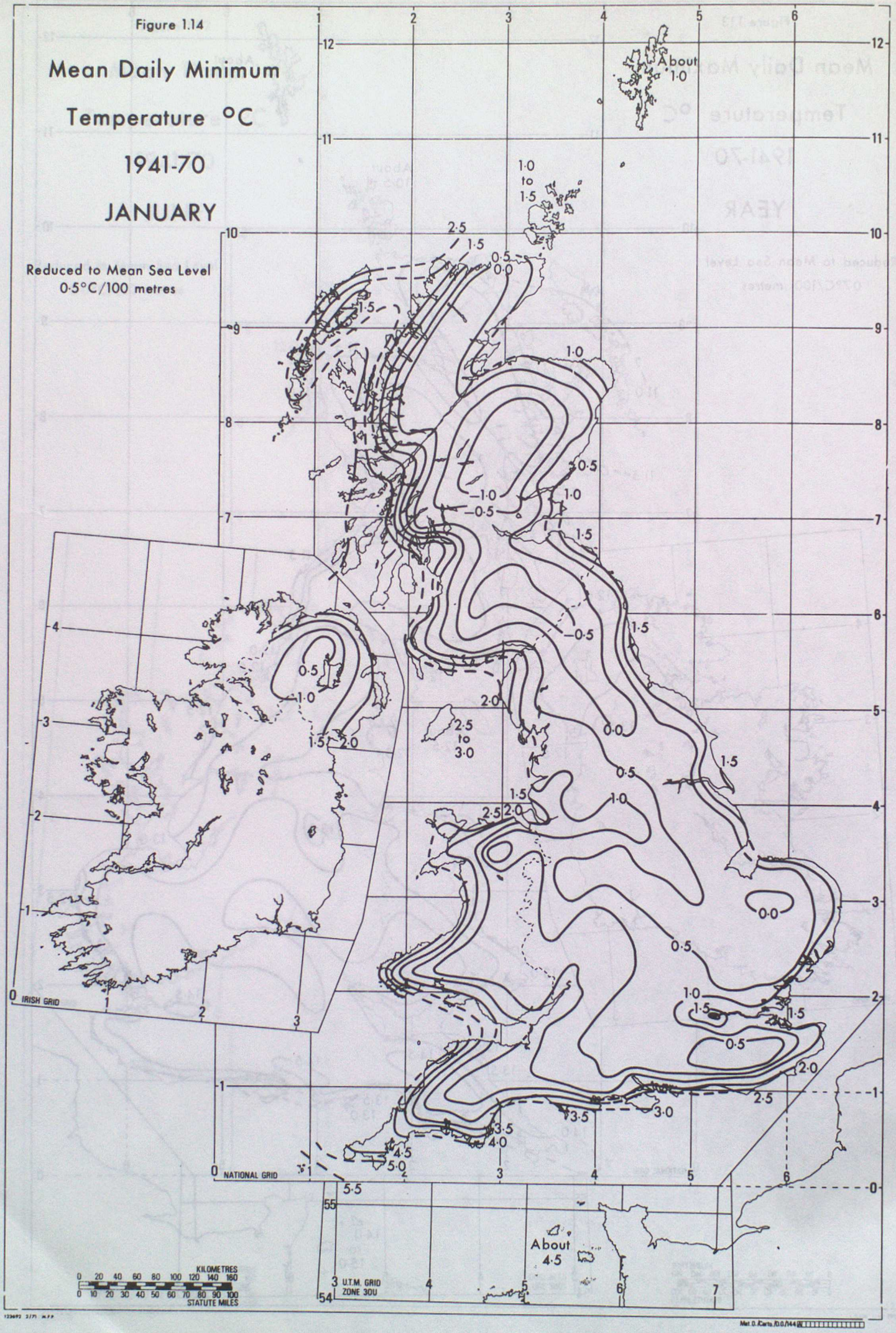


Figure 1.14
Mean Daily Minimum Temperature °C
1941-70
JANUARY
Reduced to Mean Sea Level
0·5°C/100 metres
About 1·0
1·0 to 1·5
2·5
1·5
0·5
0·0
-0·5
-1·0
2·0
2·5 to 3·0
3·0
3·5
4·0
4·5
5·0
5·5
About 4·5
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
STATUTE MILES
0 10 20 30 40 50 60 70 80 90 100

Figure 1.15

Mean Daily Minimum Temperature °C 1941-70 FEBRUARY

Reduced to Mean Sea Level
0·5°C/100 metres

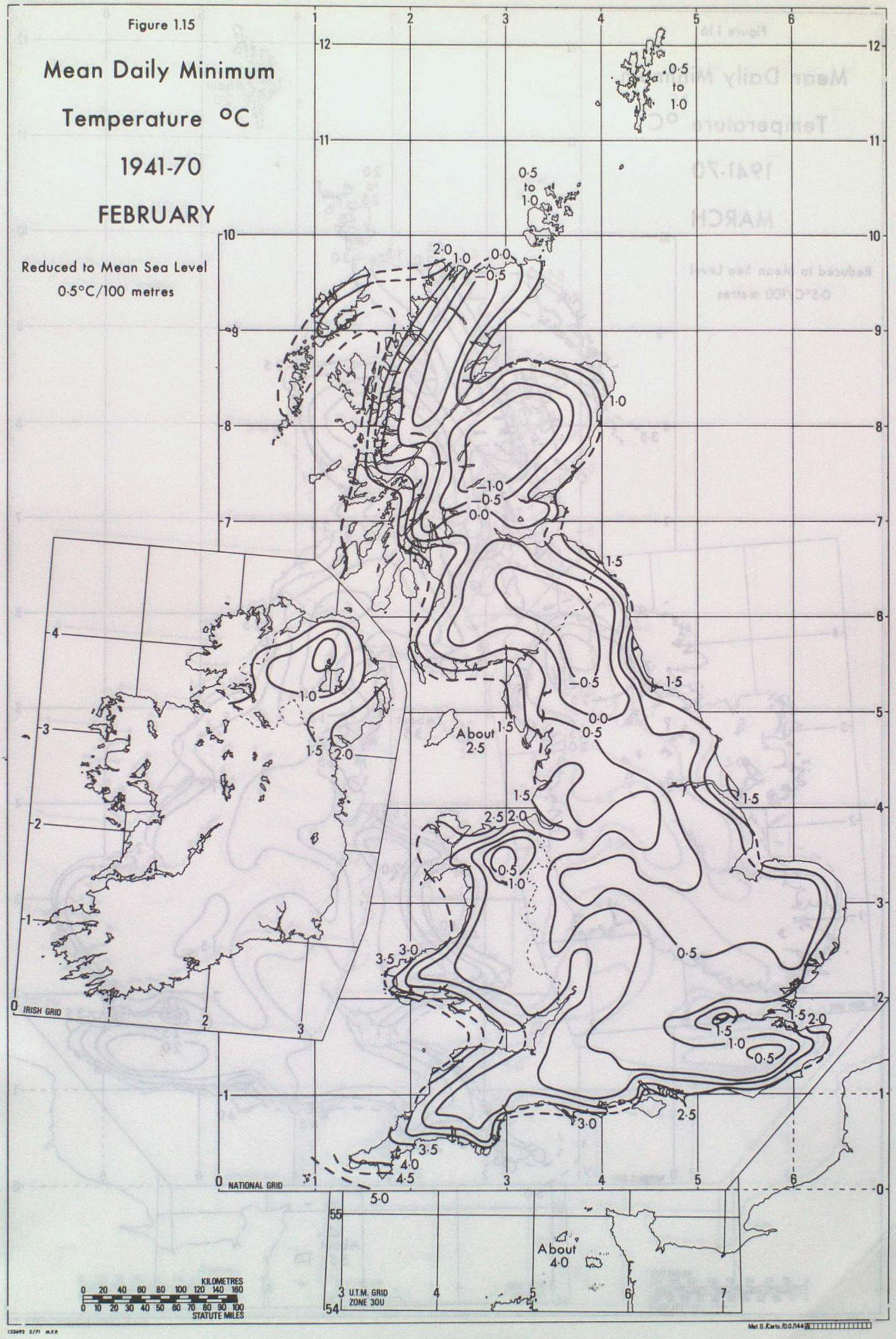


Figure 1.16

Mean Daily Minimum Temperature °C 1941-70 MARCH

Reduced to Mean Sea Level
0·5°C/100 metres

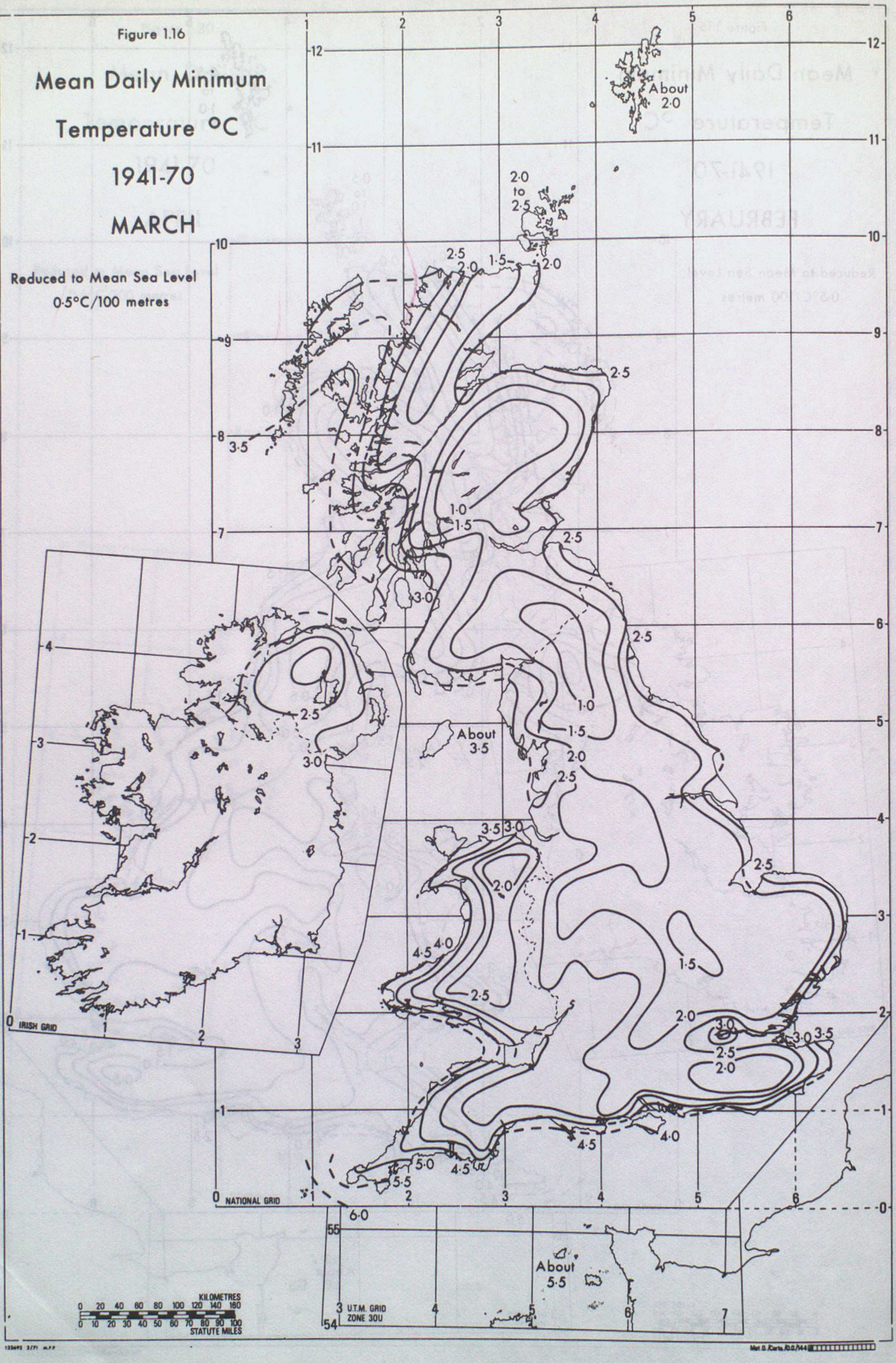


Figure 1.17

Mean Daily Minimum Temperature °C 1941-70 APRIL

Reduced to Mean Sea Level
0·5°C/100 metres

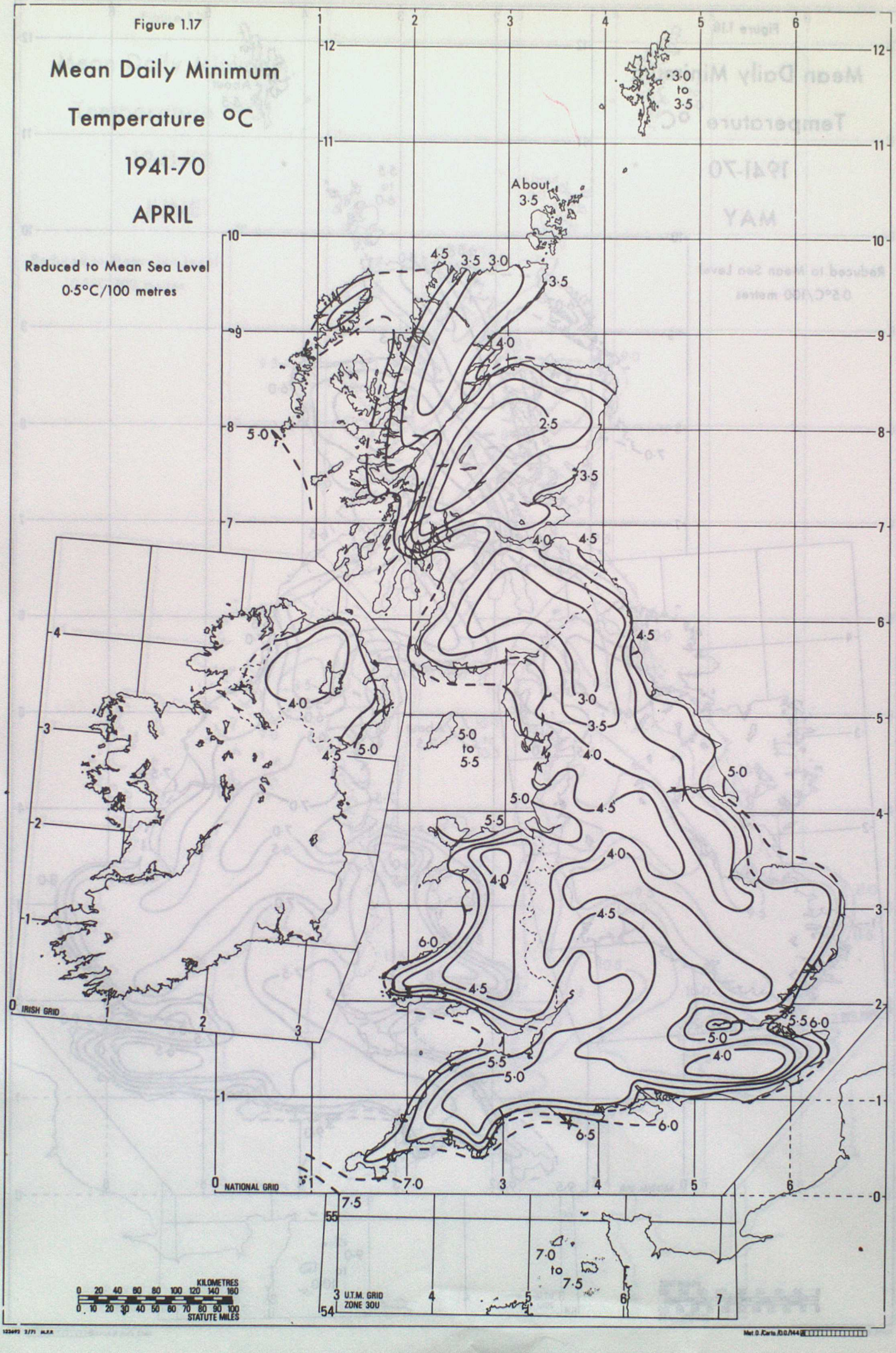


Figure 1.18

Mean Daily Minimum Temperature °C 1941-70 MAY

Reduced to Mean Sea Level
0·5°C/100 metres

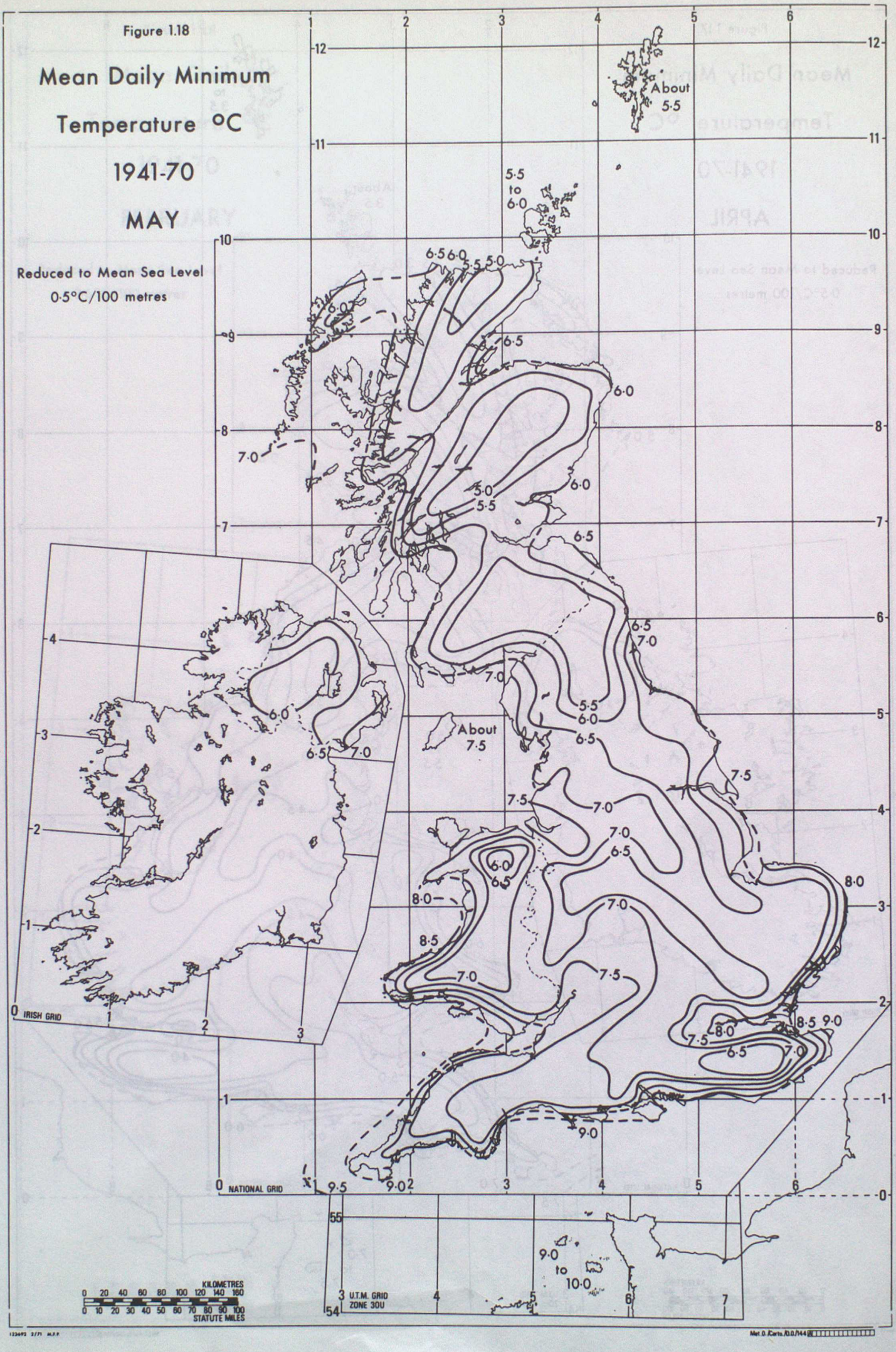


Figure 1.19

Mean Daily Minimum Temperature °C 1941-70 JUNE

Reduced to Mean Sea Level
0·5°C/100 metres

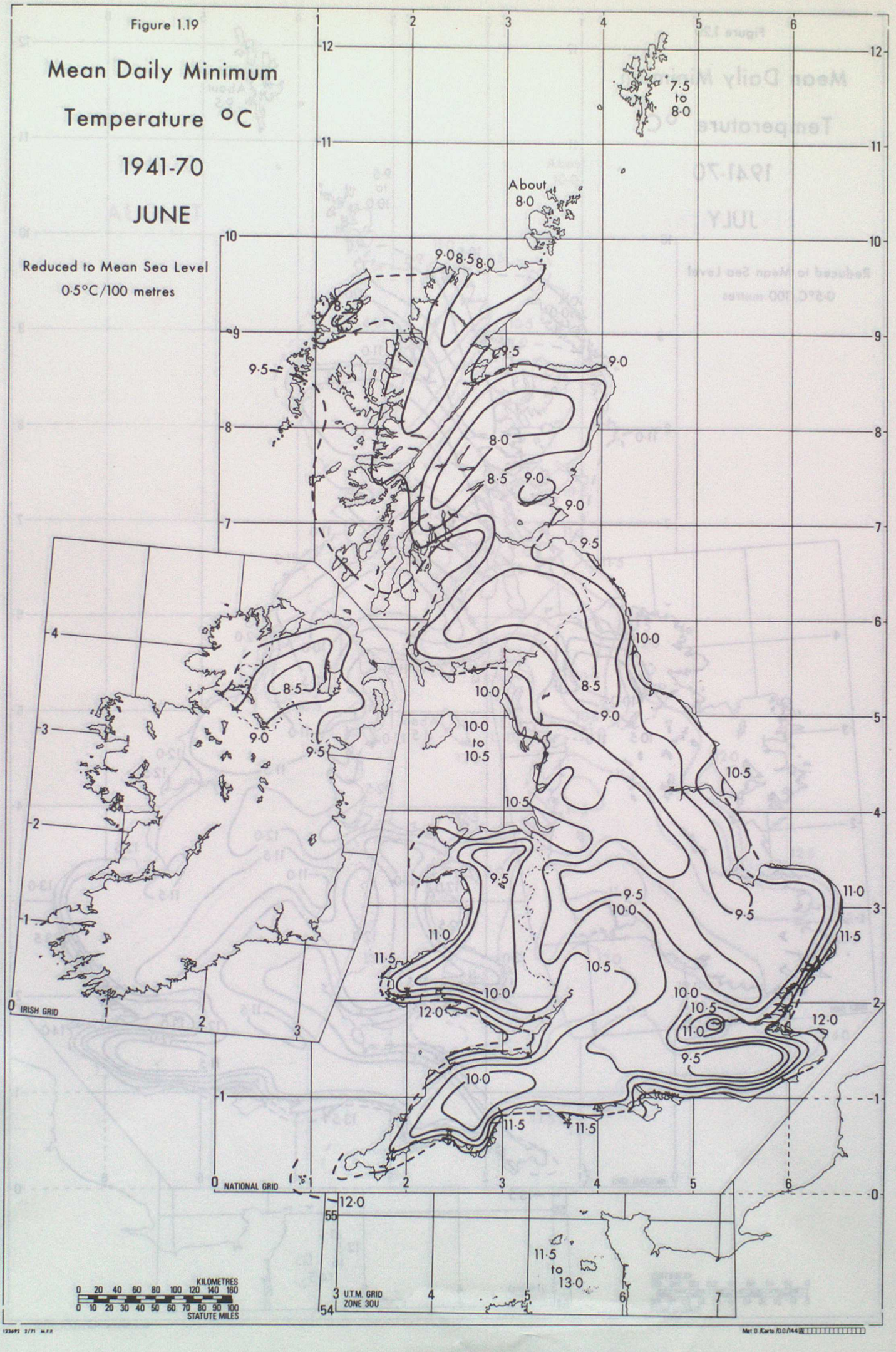


Figure 1.20

Mean Daily Minimum Temperature °C 1941-70 JULY

Reduced to Mean Sea Level
0·5°C/100 metres

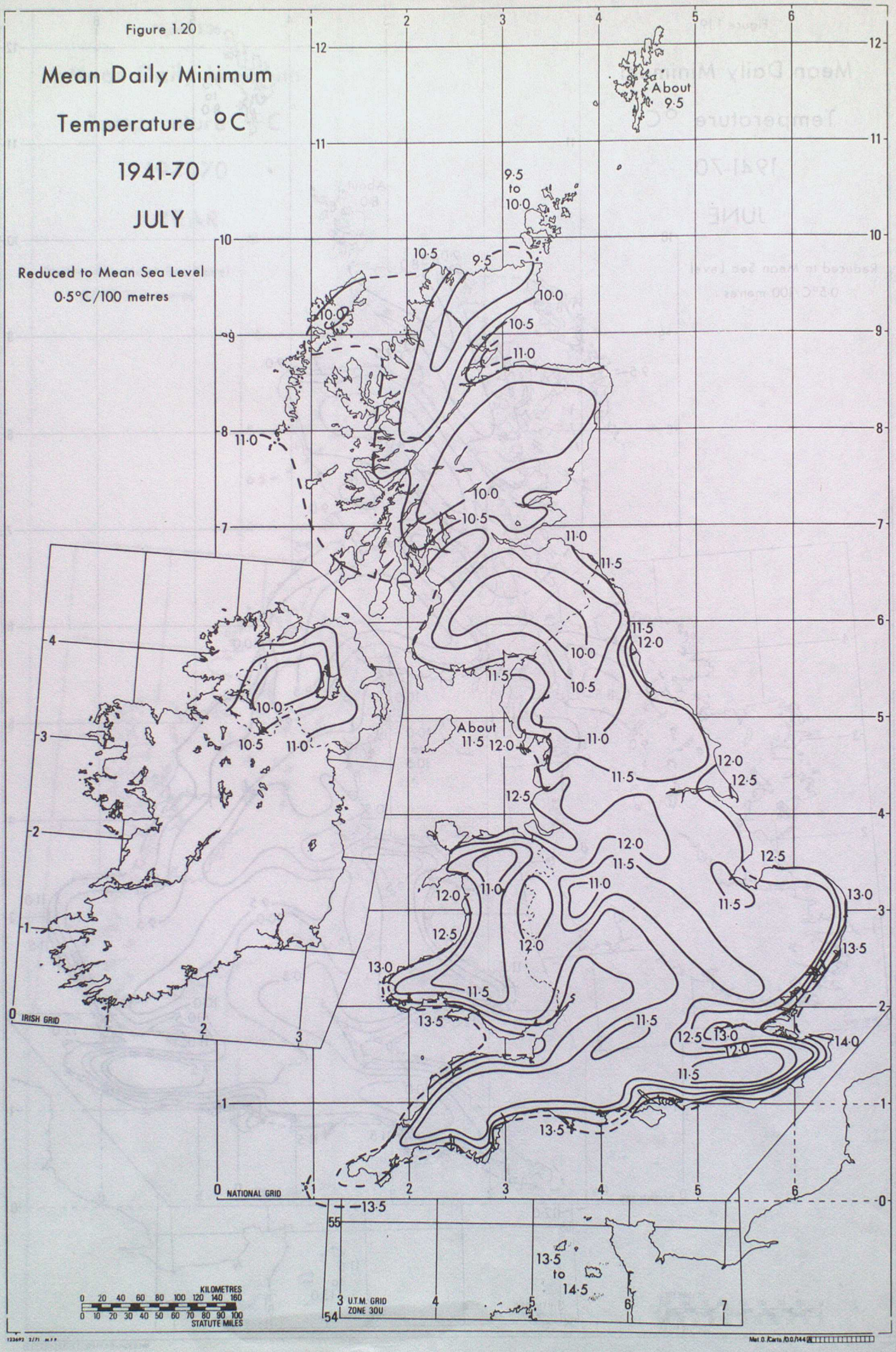
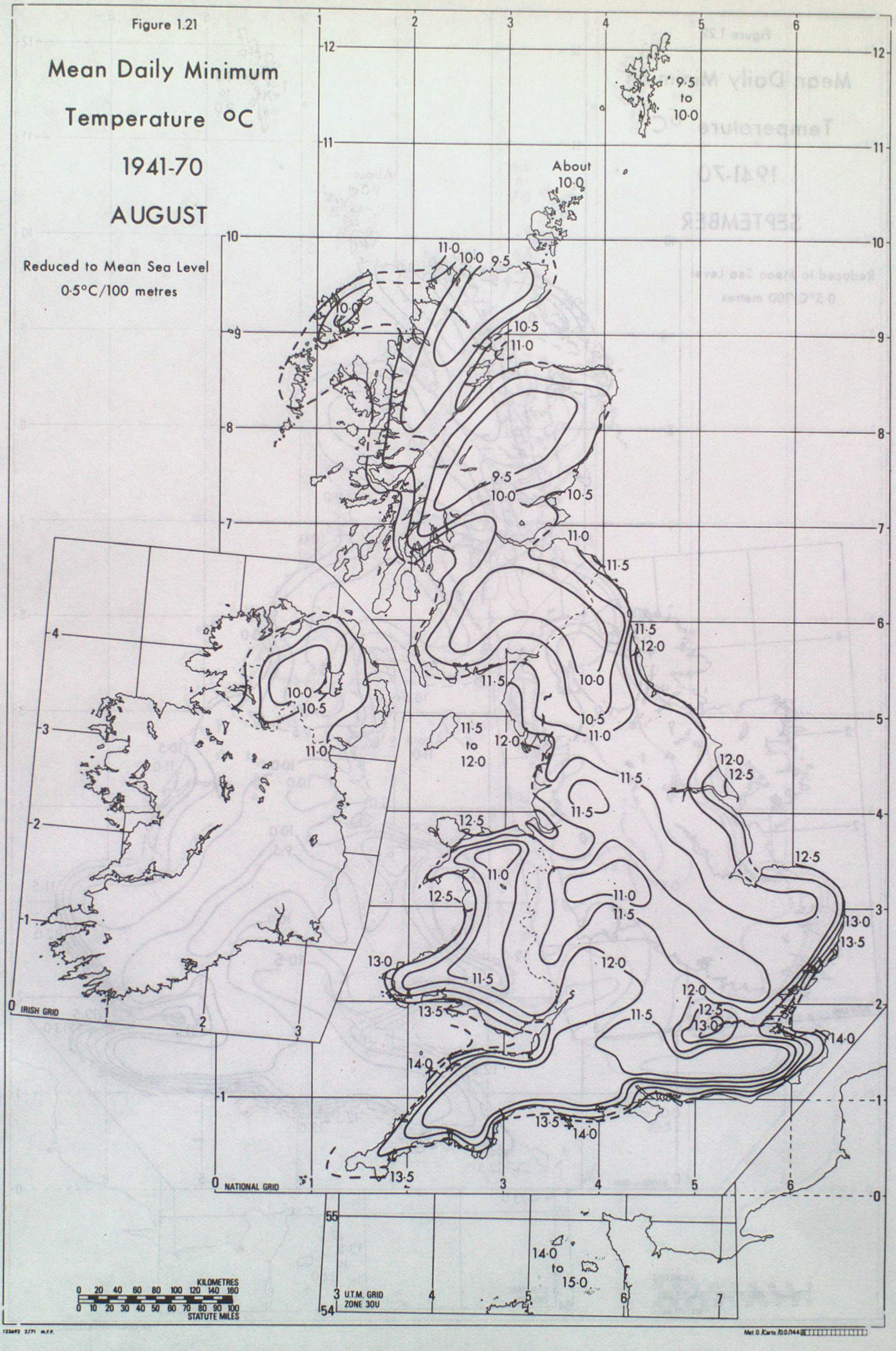


Figure 1.21

Mean Daily Minimum Temperature °C 1941-70 AUGUST

Reduced to Mean Sea Level
0·5°C/100 metres



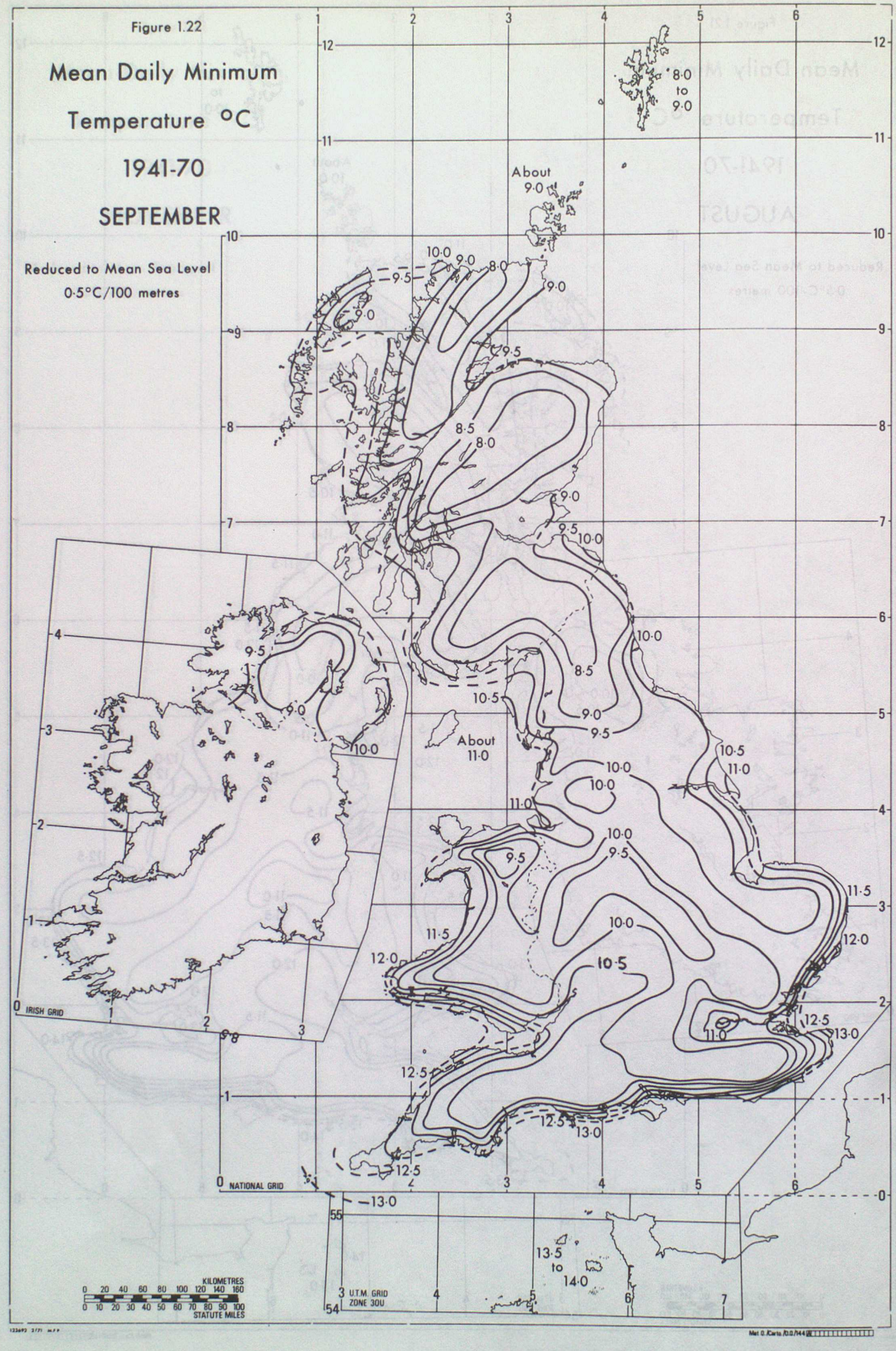


Figure 1.22
Mean Daily Minimum Temperature °C
1941-70
SEPTEMBER
Reduced to Mean Sea Level
0·5°C/100 metres
8·0 to 9·0
About 9·0
10·0
9·0
8·0
9·5
9·0
9·5
8·5
8·0
9·0
9·5
10·0
10·0
9·5
8·5
10·5
9·0
9·5
About 11·0
10·5
11·0
10·0
10·0
11·0
10·0
9·5
9·5
11·5
10·0
12·0
11·5
10·5
12·0
11·0
12·5
13·0
12·5
12·5
13·0
12·5
13·0
13·5 to 14·0
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
0 10 20 30 40 50 60 70 80 90 100
STATUTE MILES

Figure 1.23

Mean Daily Minimum Temperature °C 1941-70 OCTOBER

Reduced to Mean Sea Level
0·5°C/100 metres

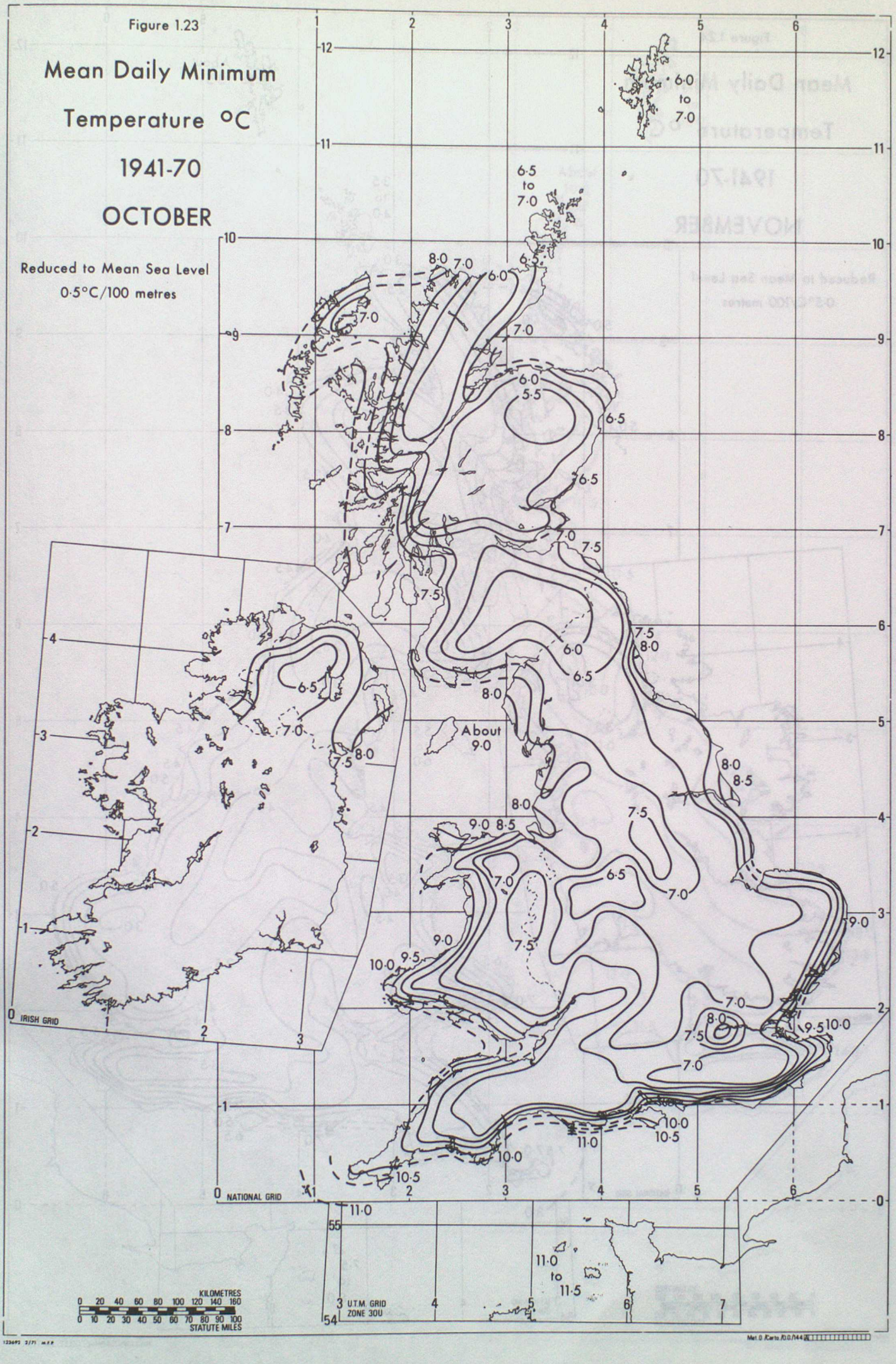


Figure 1.24

Mean Daily Minimum Temperature °C 1941-70 NOVEMBER

Reduced to Mean Sea Level
0·5°C/100 metres

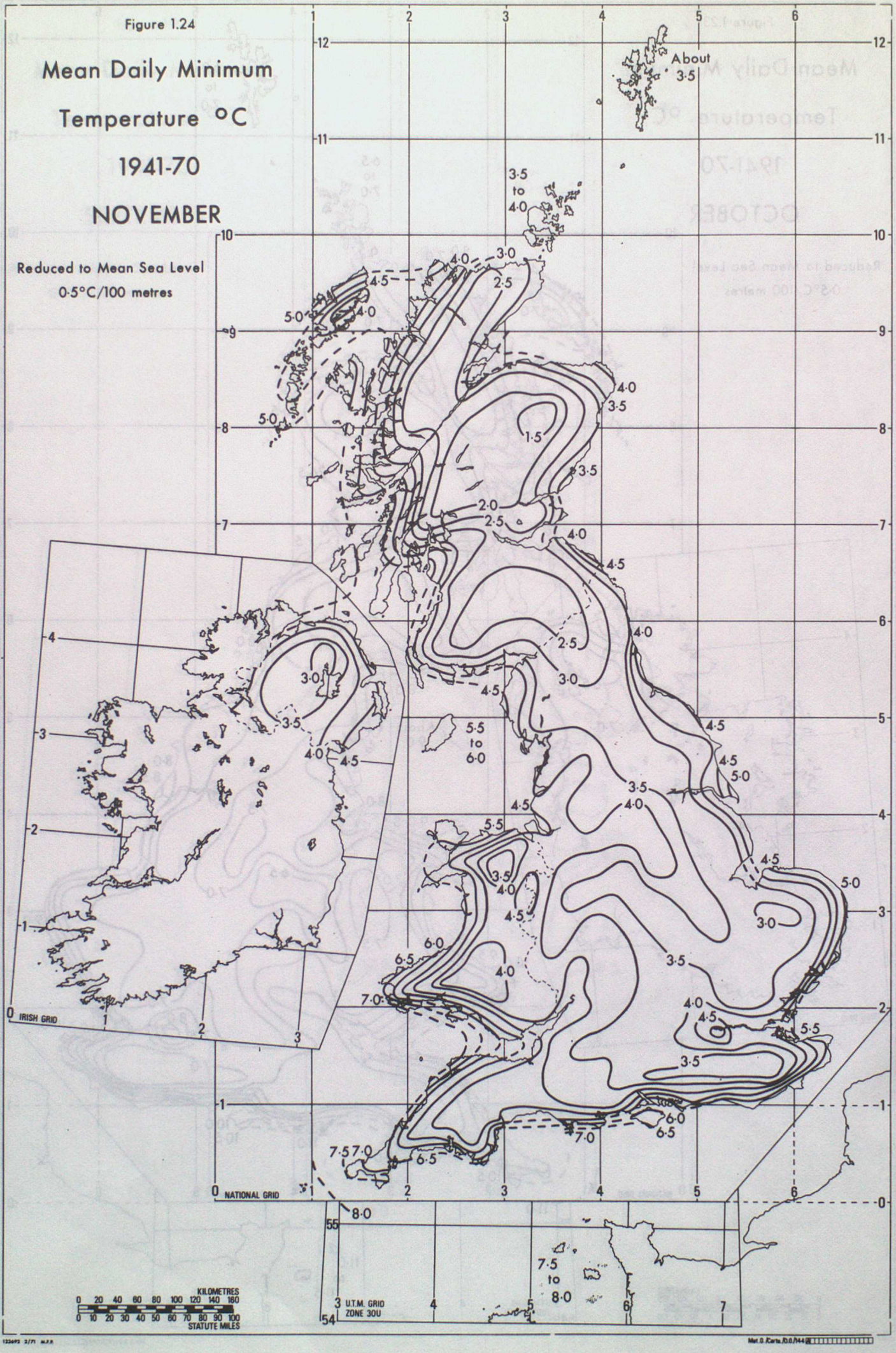


Figure 1.25

Mean Daily Minimum Temperature C 1941-70 DECEMBER

Reduced to Mean Sea Level
0·5°C/100 metres

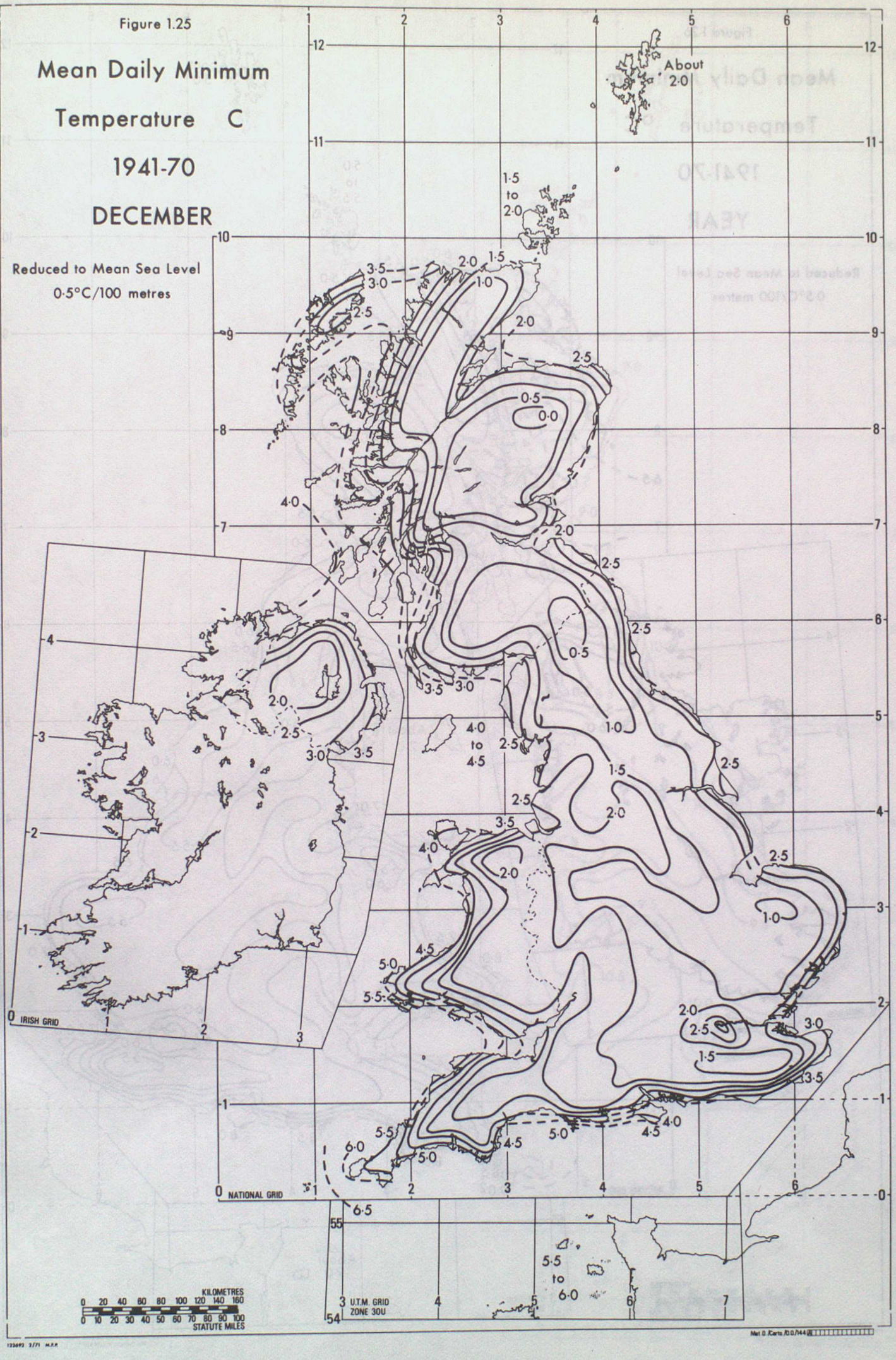


Figure 1·26

Mean Daily Minimum Temperature °C 1941-70 YEAR

Reduced to Mean Sea Level
0·5°C/100 metres

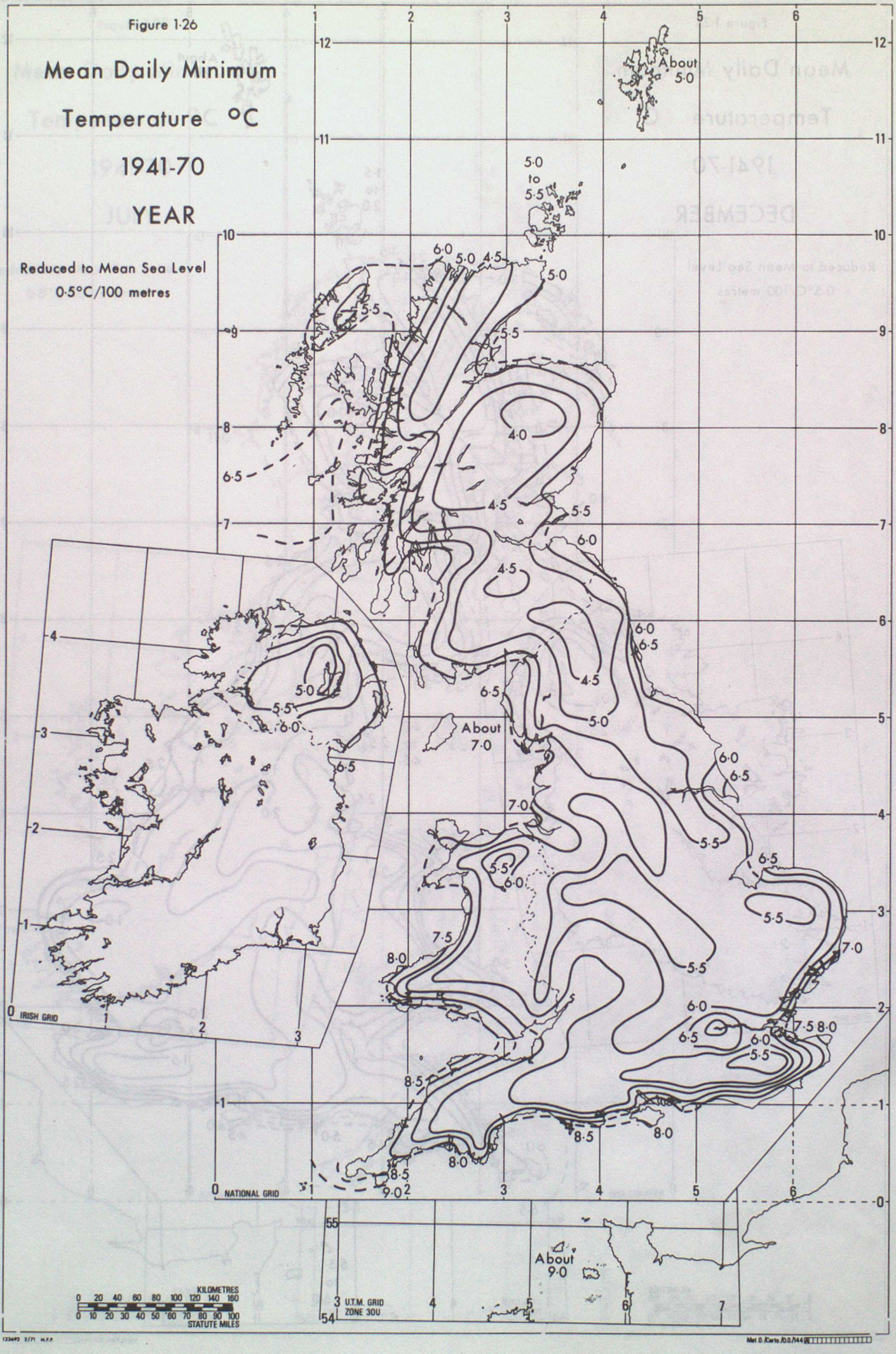


Figure 1.27

Mean Daily Temperature °C 1941-70 JANUARY

Reduced to Mean Sea Level
0·6°C/100 metres

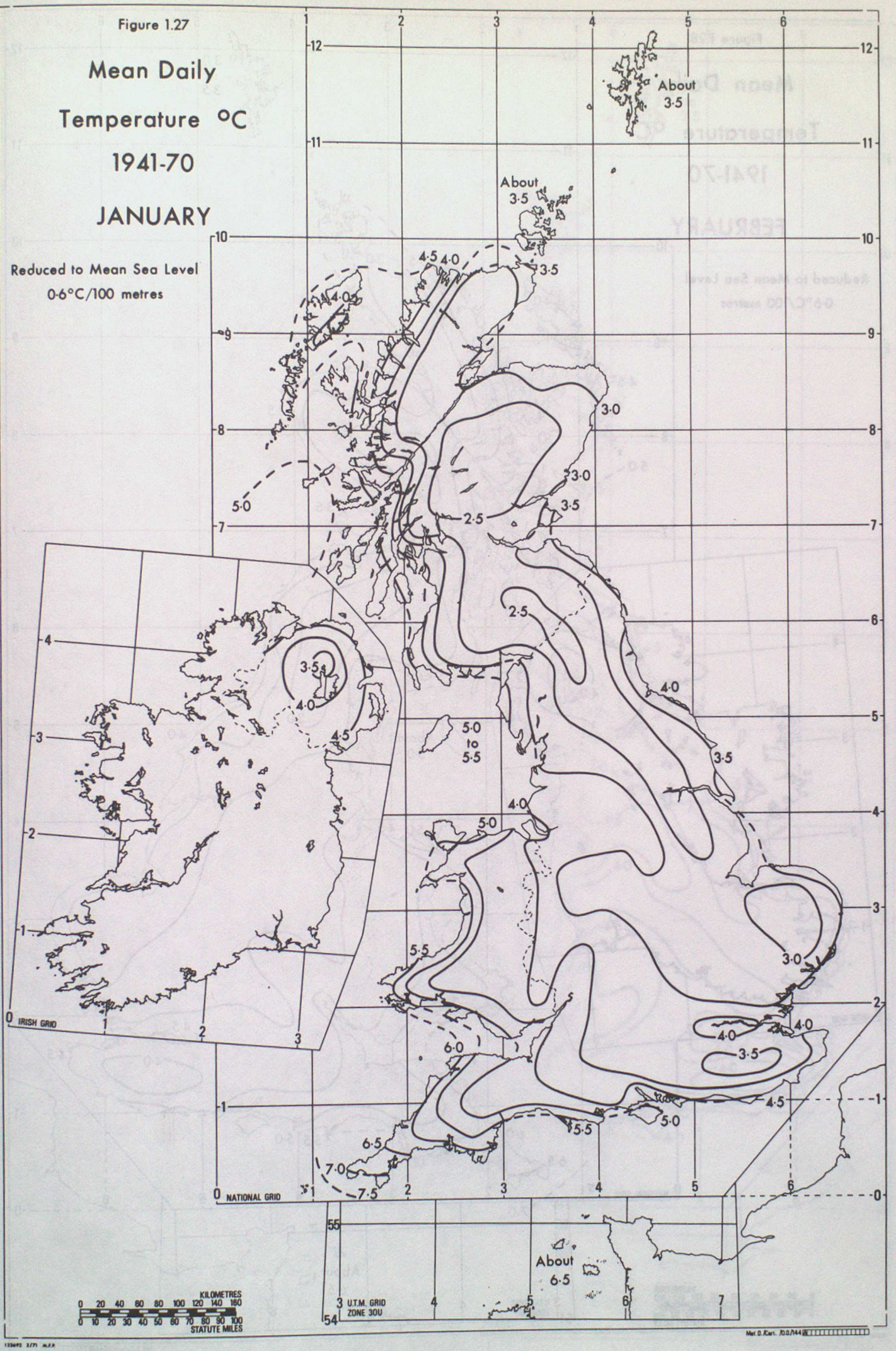


Figure 1.28

Mean Daily Temperature °C 1941-70 FEBRUARY

Reduced to Mean Sea Level
0·6°C/100 metres

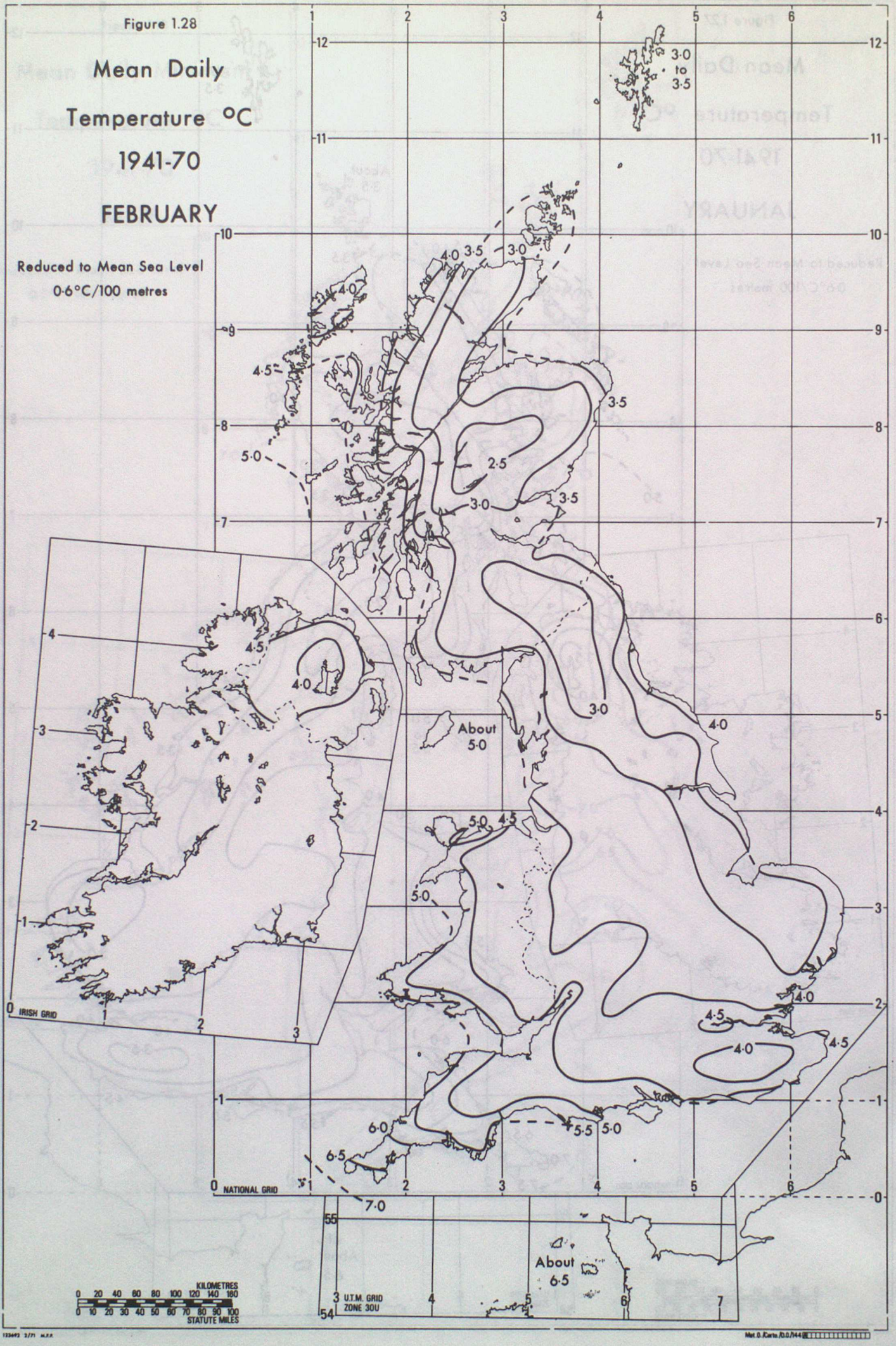


Figure 1.29

Mean Daily Temperature °C 1941-70 MARCH

Reduced to Mean Sea Level
0·6°C/100 metres

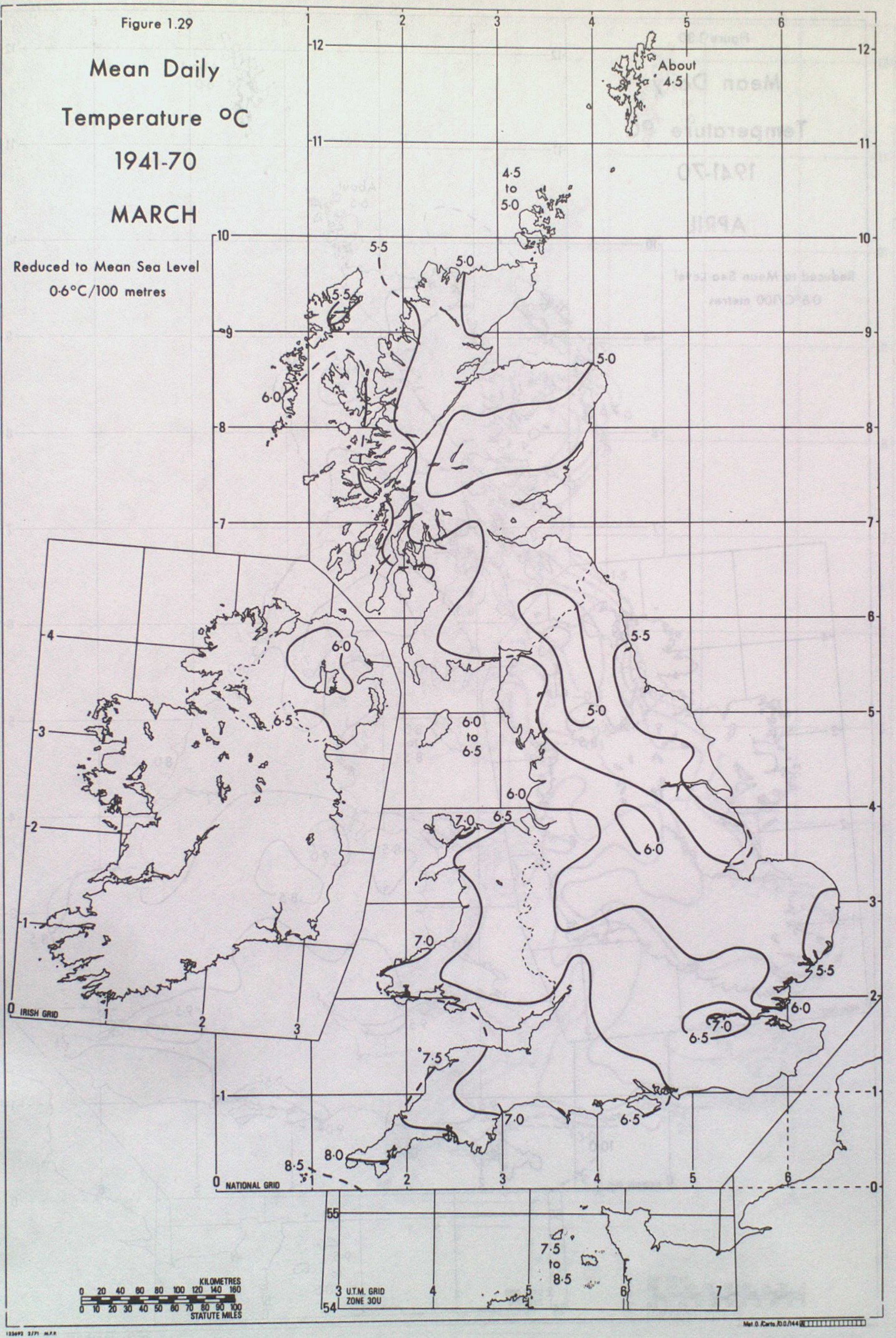


Figure 1.30

Mean Daily Temperature °C 1941-70 APRIL

Reduced to Mean Sea Level
0·6°C/100 metres

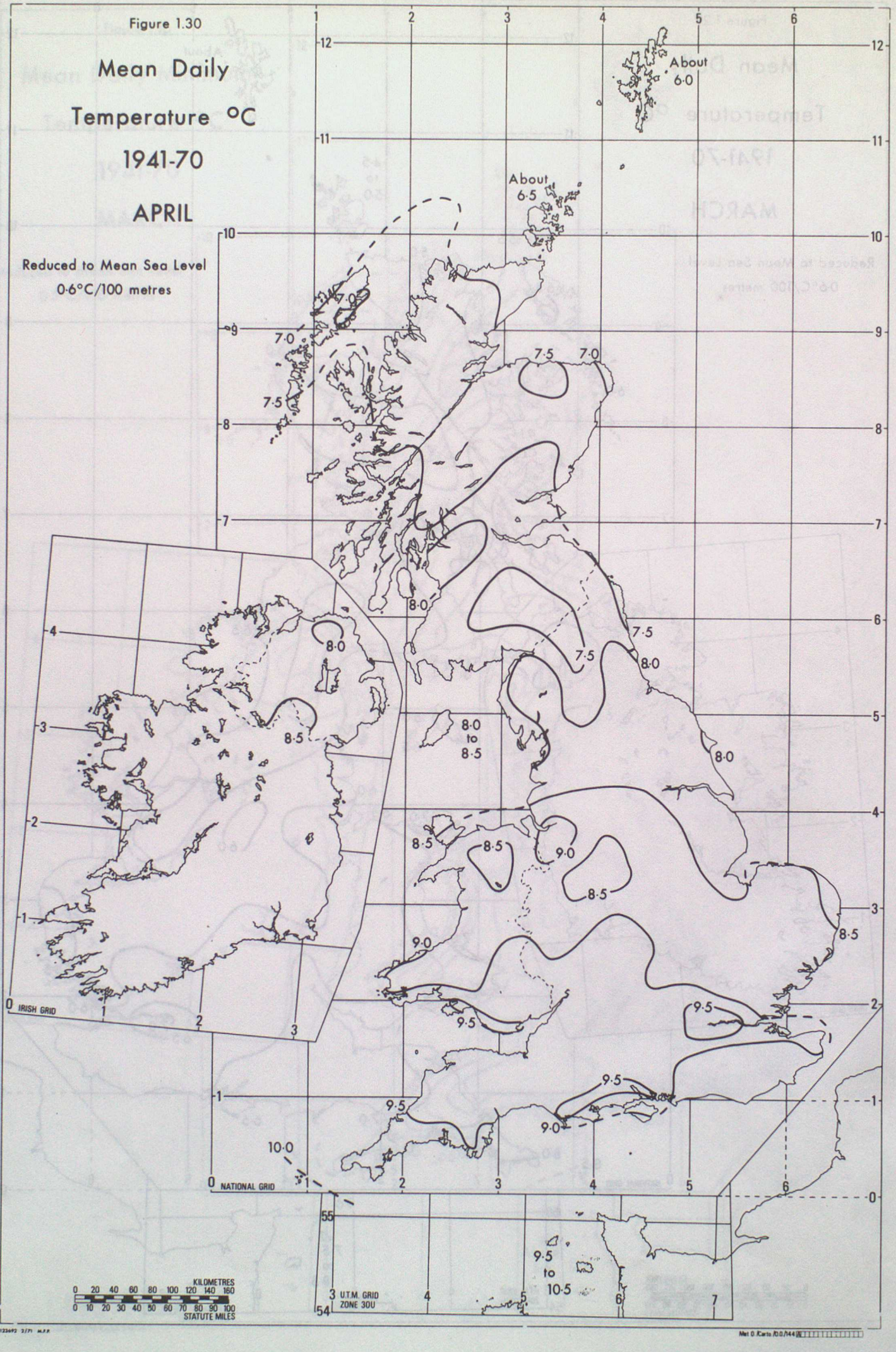


Figure 1.31

Mean Daily Temperature °C 1941-70 MAY

Reduced to Mean Sea Level
0·6°C/100 metres

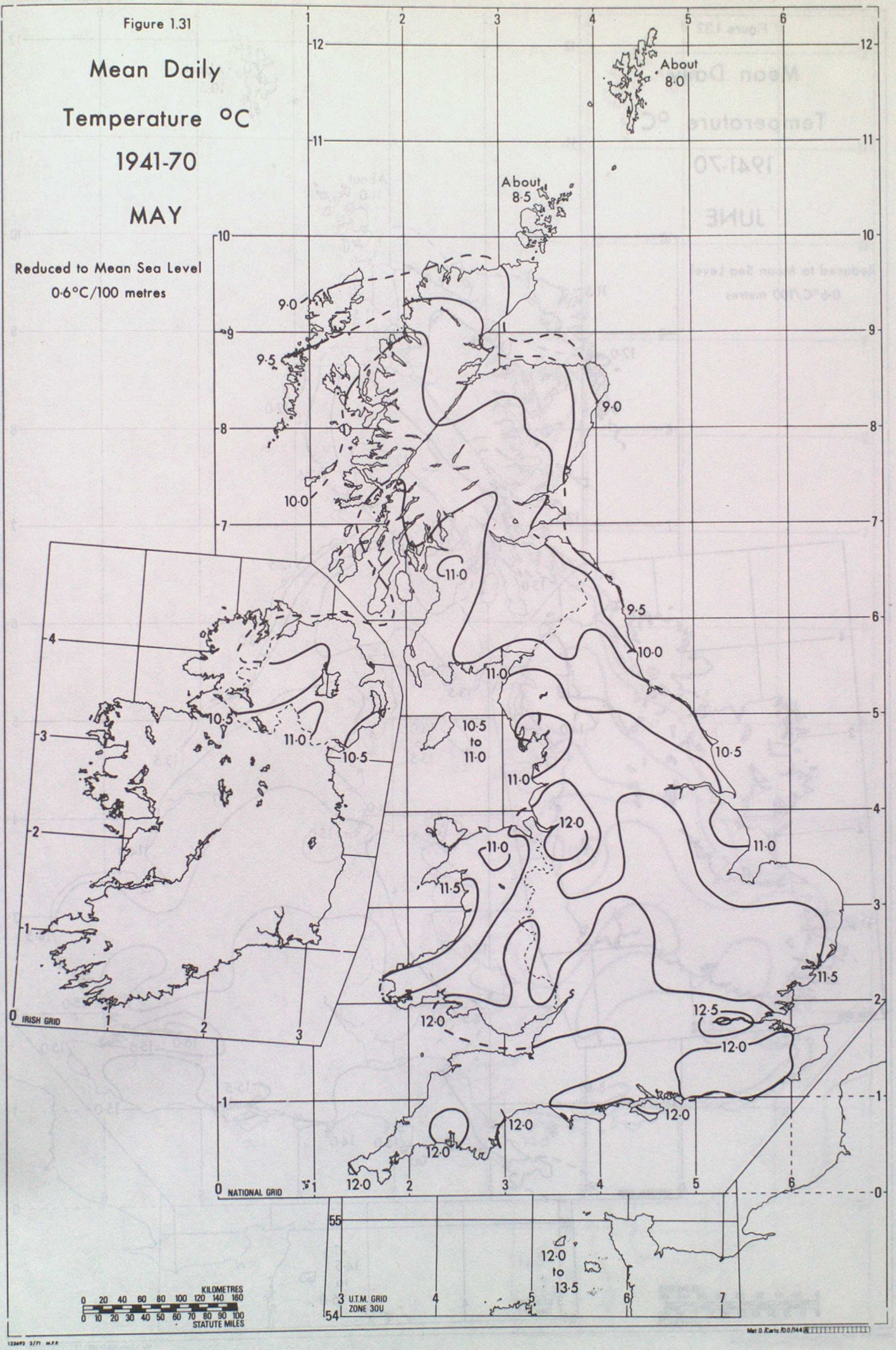


Figure 1.32

Mean Daily Temperature °C 1941-70 JUNE

Reduced to Mean Sea Level
0·6°C/100 metres

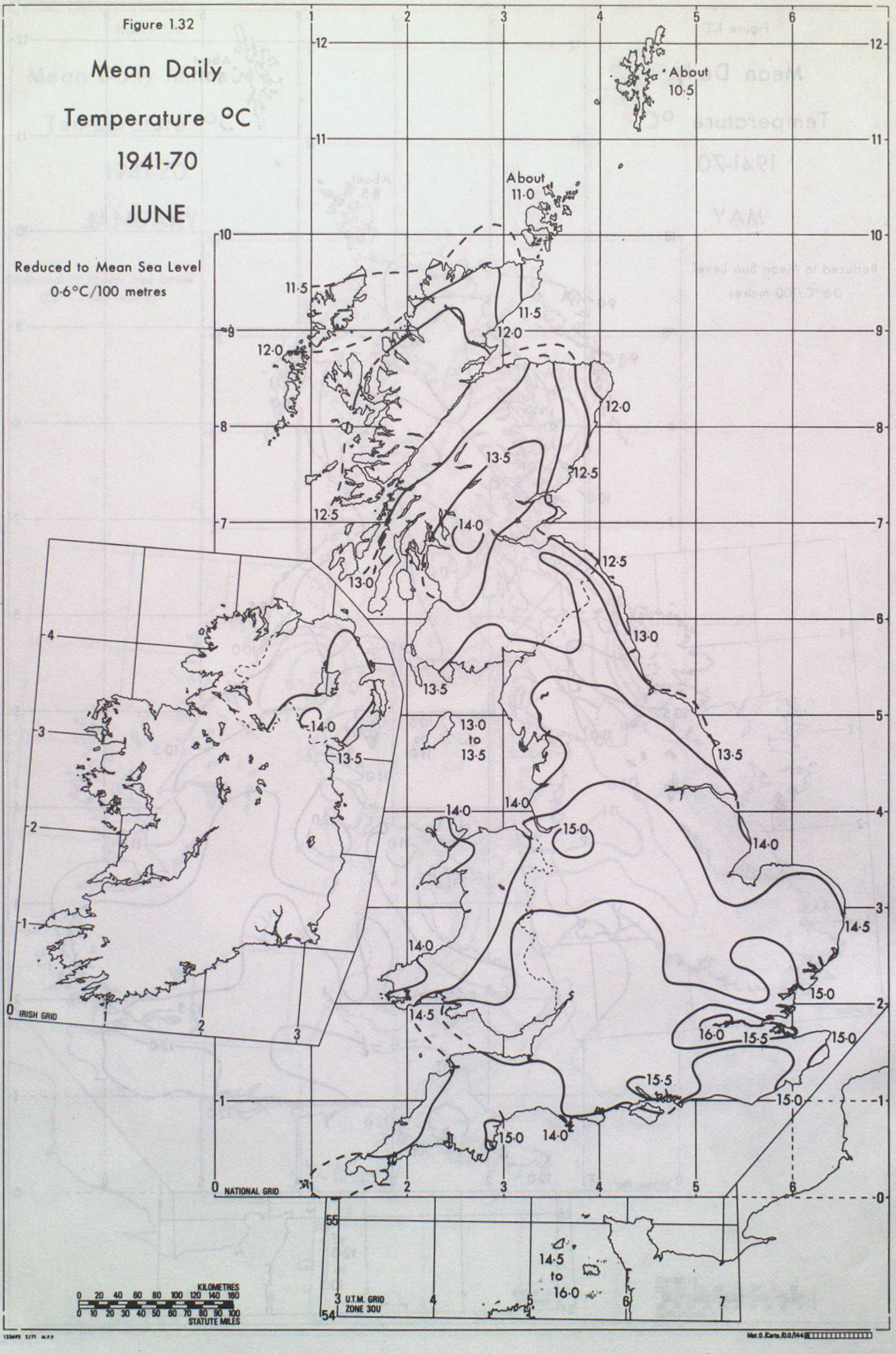
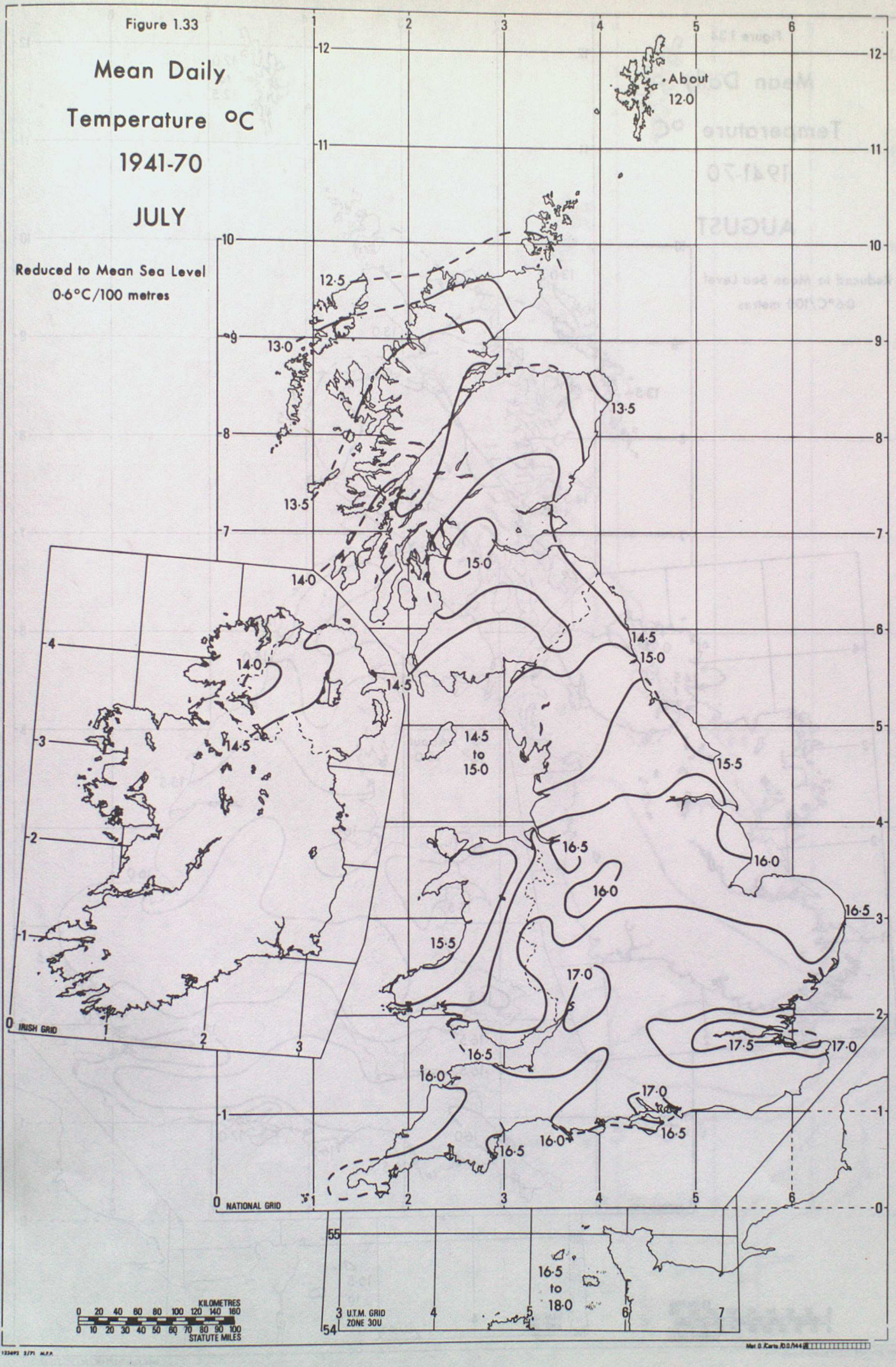


Figure 1.33

Mean Daily Temperature °C 1941-70 JULY

Reduced to Mean Sea Level
0·6°C/100 metres



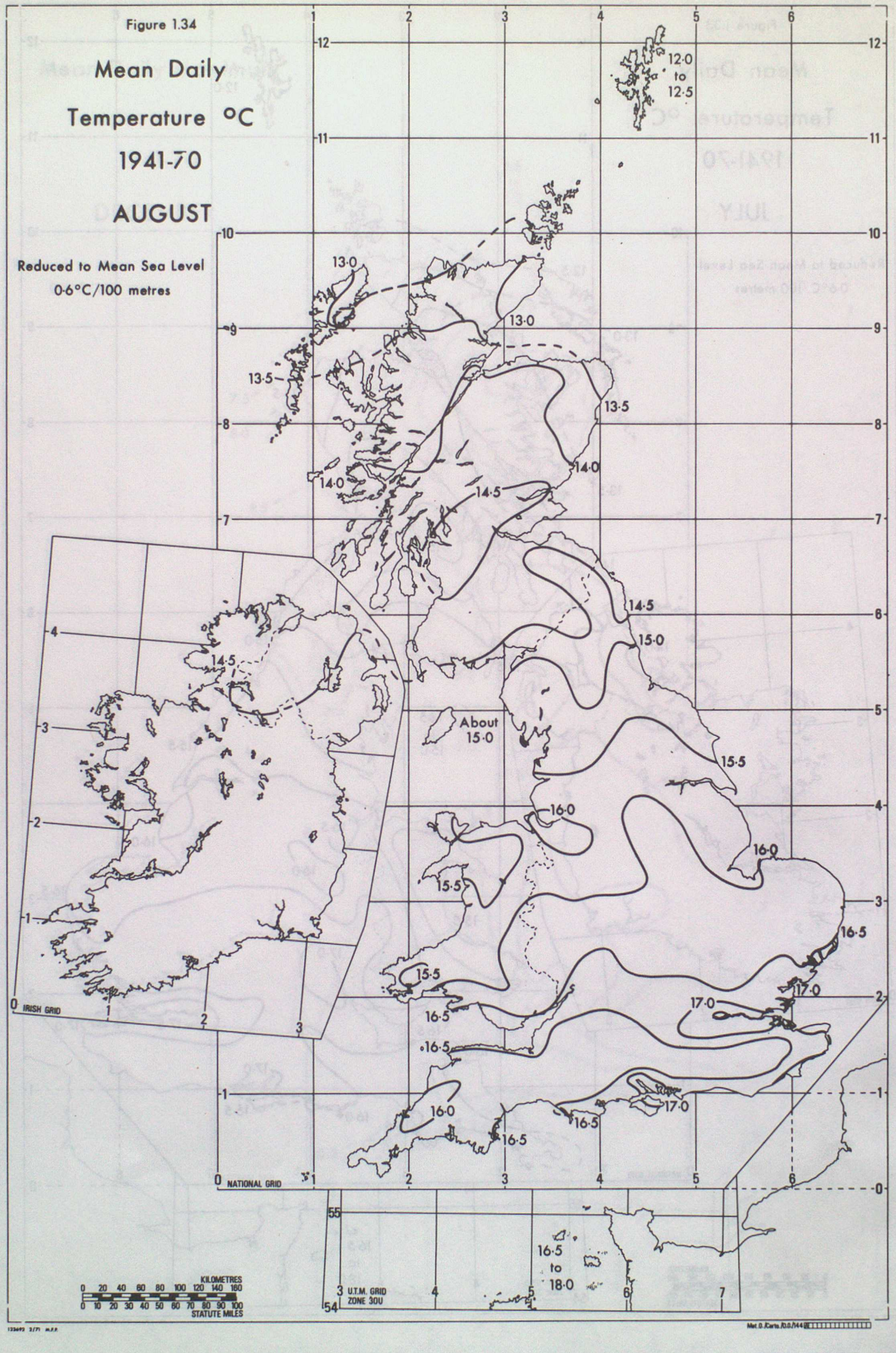
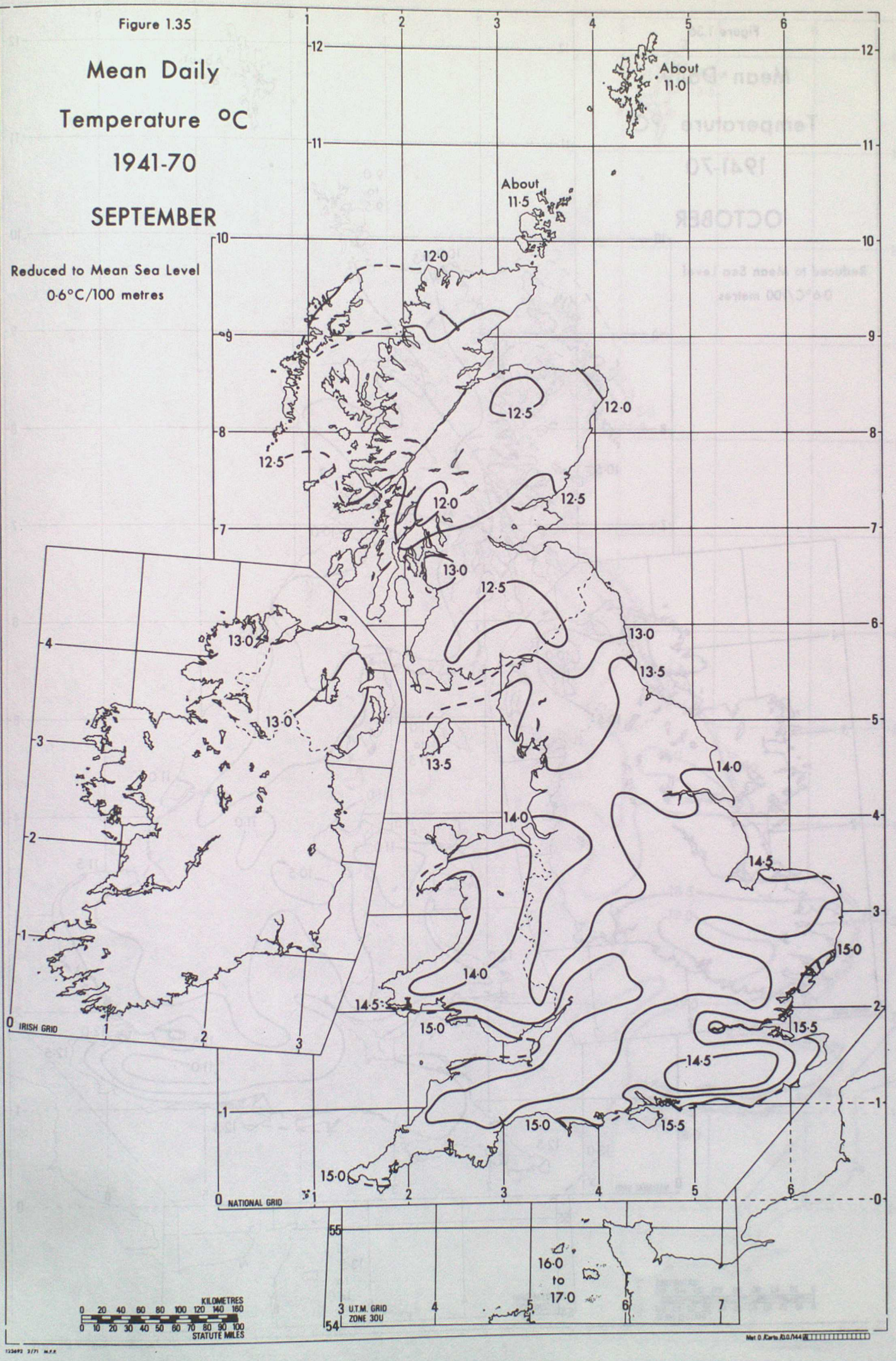


Figure 1.34
Mean Daily
Temperature °C
1941-70
AUGUST
Reduced to Mean Sea Level
0·6°C/100 metres
12·0
to
12·5
13·0
13·0
13·5
13·5
14·0
14·0
14·5
14·5
15·0
About
15·0
15·5
16·0
16·0
15·5
16·5
15·5
17·0
17·0
16·5
16·5
16·0
16·5
17·0
16·5
16·5
to
18·0
IRISH GRID
NATIONAL GRID
U.T.M. GRID
ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
0 10 20 30 40 50 60 70 80 90 100
STATUTE MILES

Figure 1.35

Mean Daily Temperature °C 1941-70 SEPTEMBER

Reduced to Mean Sea Level
0·6°C/100 metres



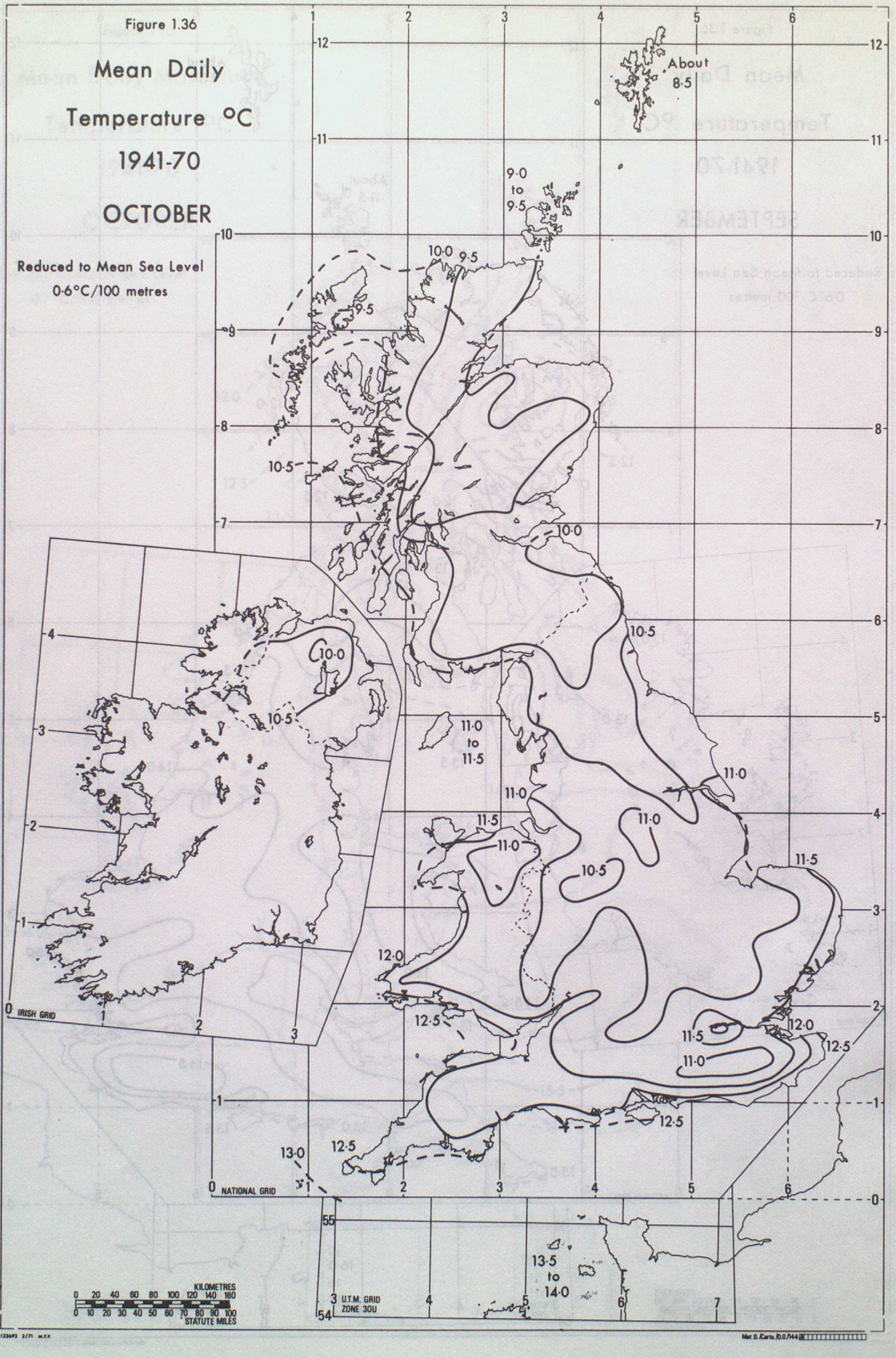


Figure 1.36
Mean Daily
Temperature °C
1941-70
OCTOBER
Reduced to Mean Sea Level
0·6°C/100 metres
About
8·5
9·0
to
9·5
10·0
9·5
9·5
10·5
10·0
10·5
10·0
11·0
to
11·5
11·0
11·0
11·5
11·0
10·5
11·5
12·0
12·5
11·5
12·0
12·5
11·0
12·5
13·0
12·5
13·5
to
14·0
IRISH GRID
NATIONAL GRID
U.T.M. GRID
ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
STATUTE MILES
0 10 20 30 40 50 60 70 80 90 100

Figure 1.37

Mean Daily Temperature °C 1941-70 NOVEMBER

Reduced to Mean Sea Level
0·6°C/100 metres

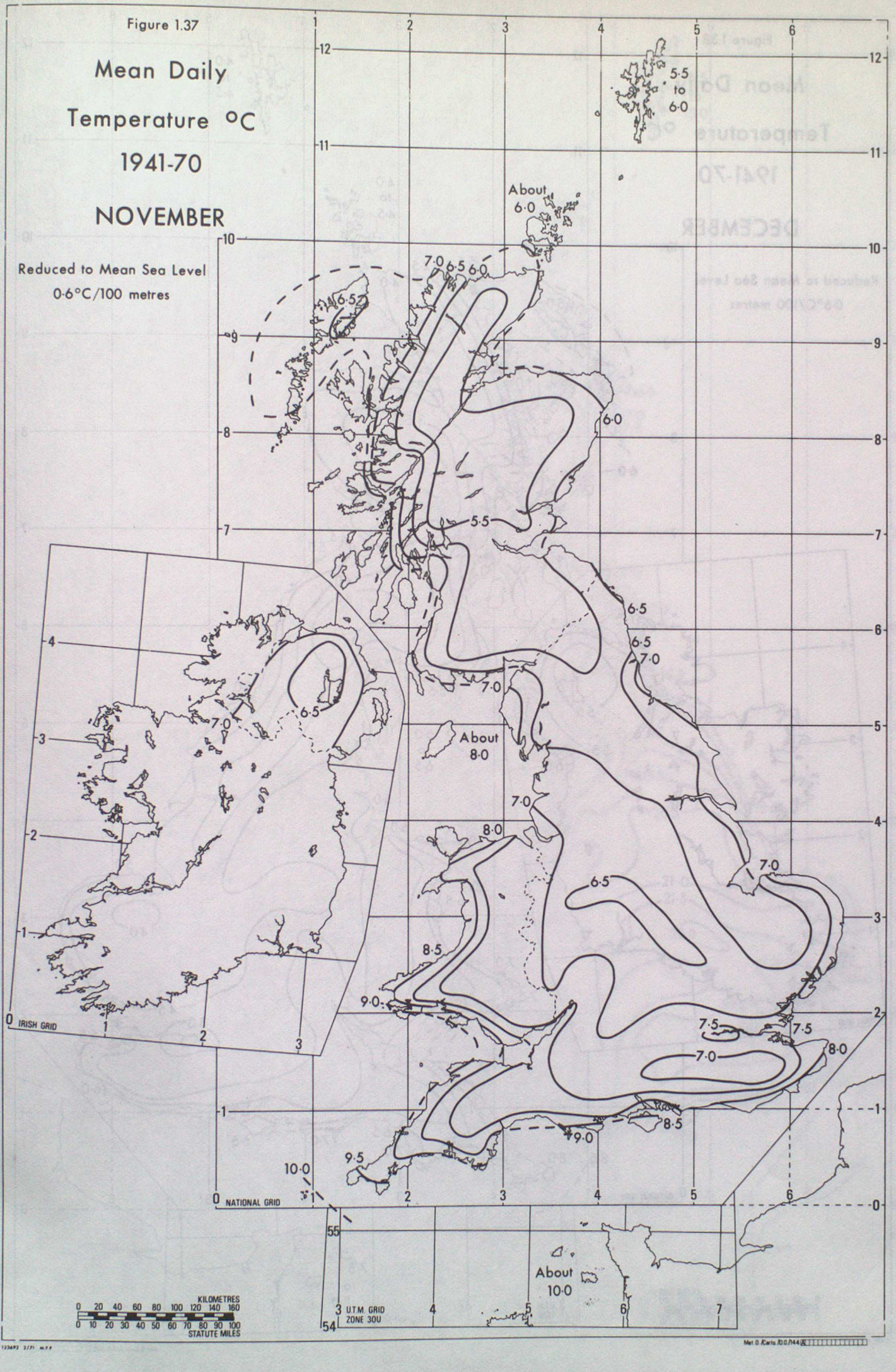


Figure 1.38

Mean Daily Temperature °C 1941-70 DECEMBER

Reduced to Mean Sea Level
0·6°C/100 metres

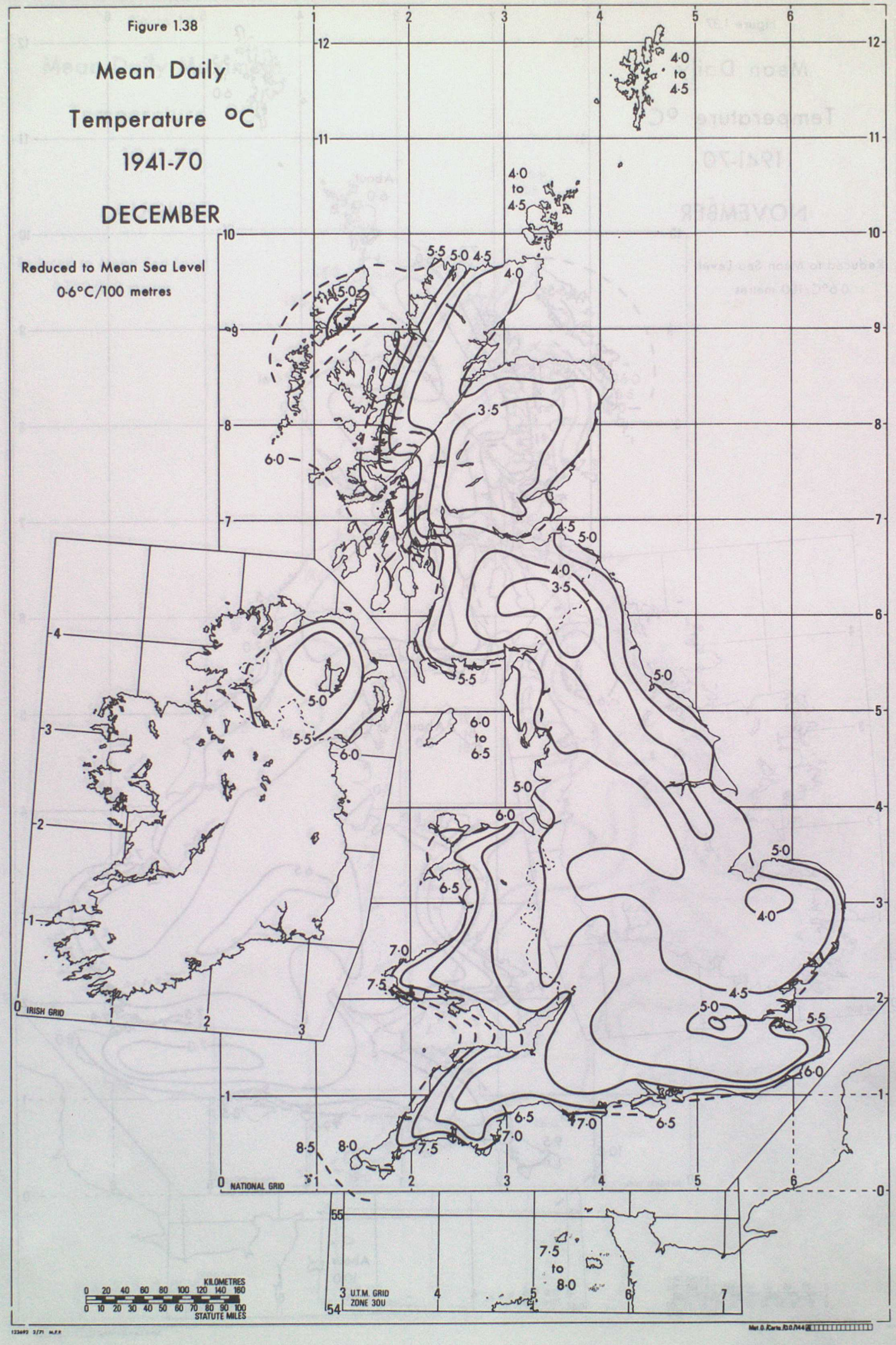
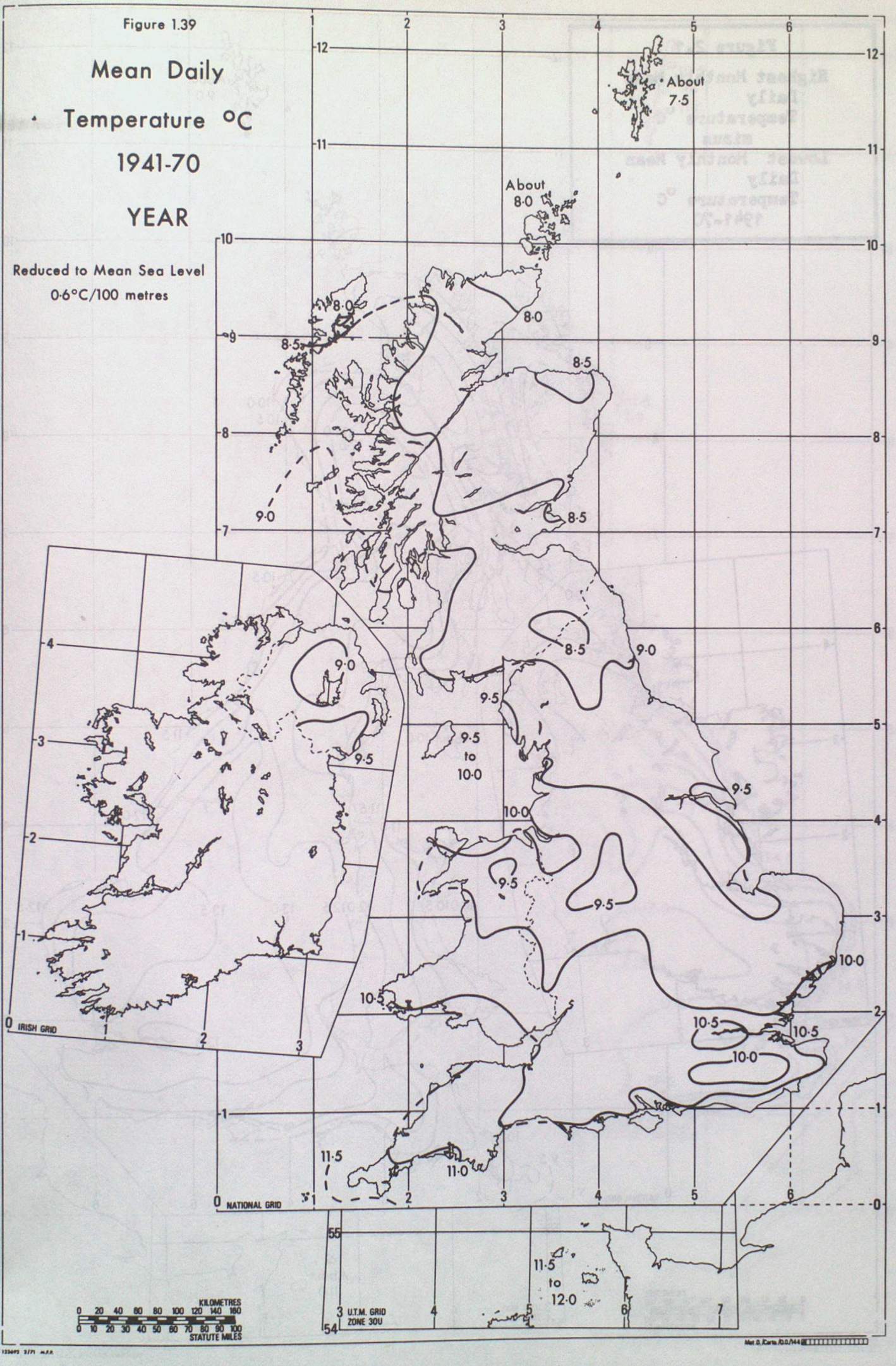


Figure 1.39

Mean Daily Temperature °C 1941-70 YEAR

Reduced to Mean Sea Level
0·6°C/100 metres



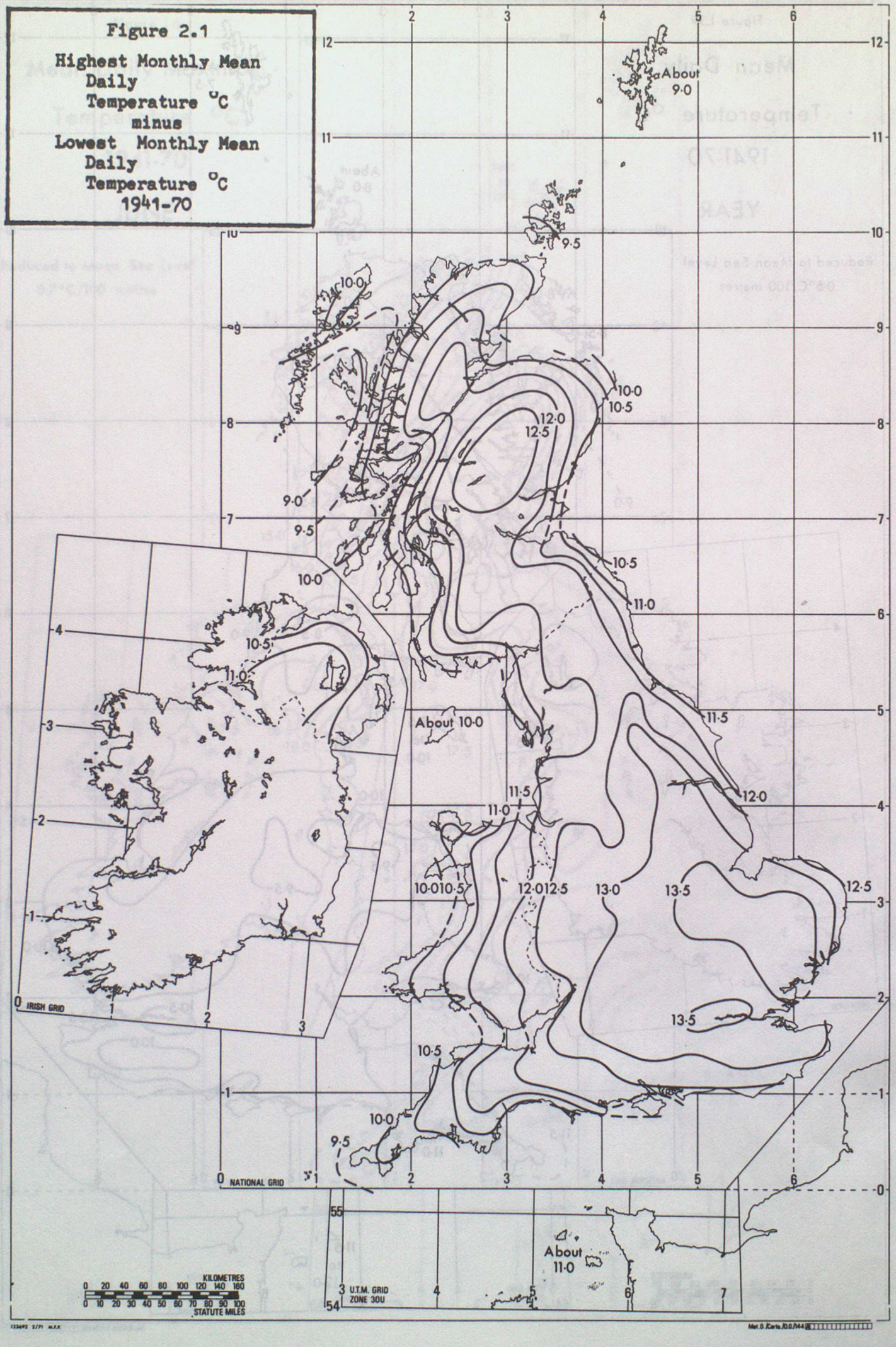


Figure 2.1
Highest Monthly Mean Daily Temperature °C minus Lowest Monthly Mean Daily Temperature °C 1941-70
About 9·0
9·5
10·0
10·5
11·0
11·5
12·0
12·5
13·0
13·5
About 10·0
About 11·0
IRISH GRID
NATIONAL GRID
U.T.M. GRID ZONE 30U
KILOMETRES
0 20 40 60 80 100 120 140 160
0 10 20 30 40 50 60 70 80 90 100
STATUTE MILES

Figure 3.1

Mean Annual Maximum Temperature °C 1941-70

Reduced to Mean Sea Level
1·0°C/100 metres

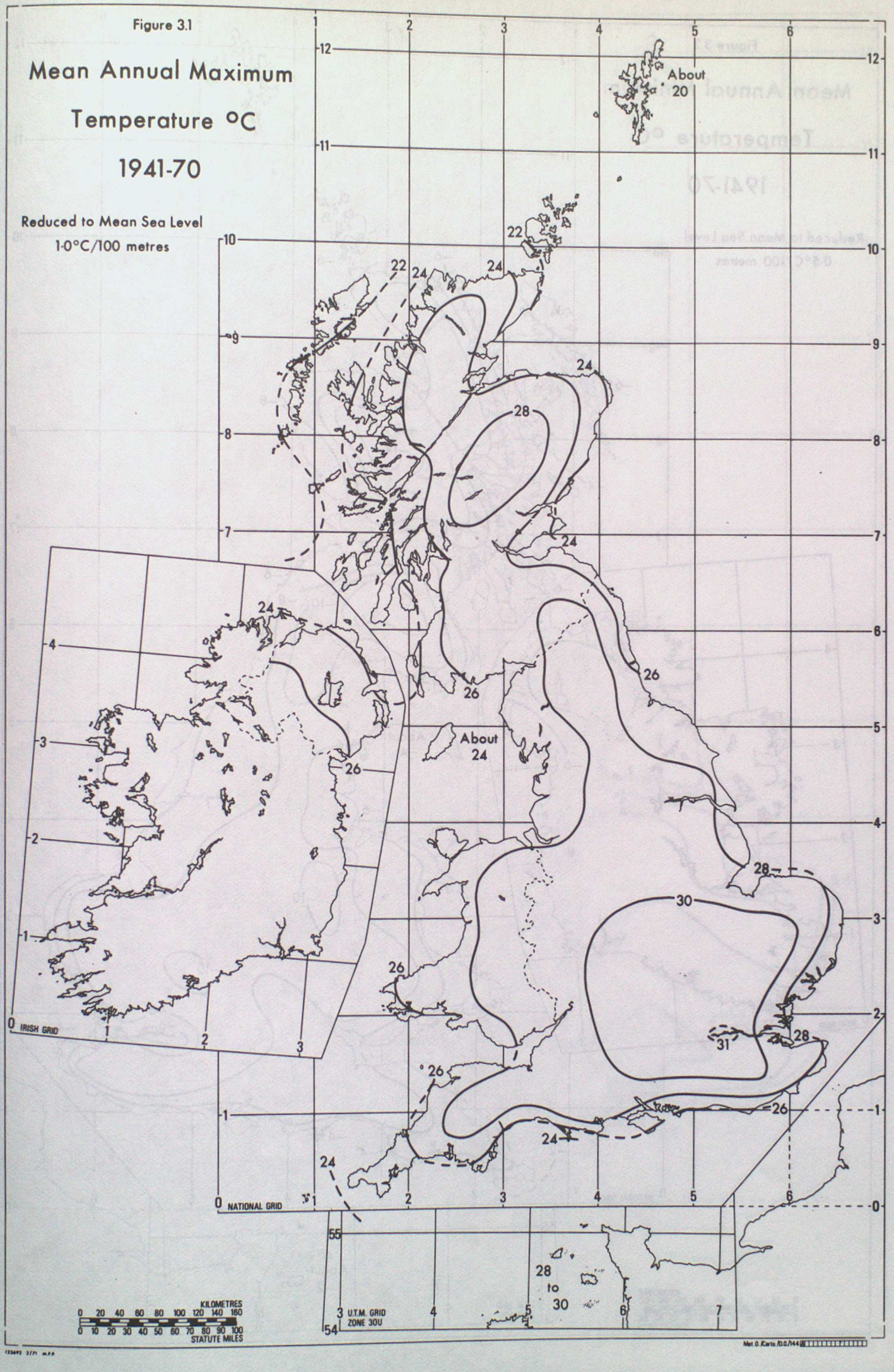


Figure 3.2

Mean Annual Minimum Temperature °C 1941-70

Reduced to Mean Sea Level
0·5°C/100 metres

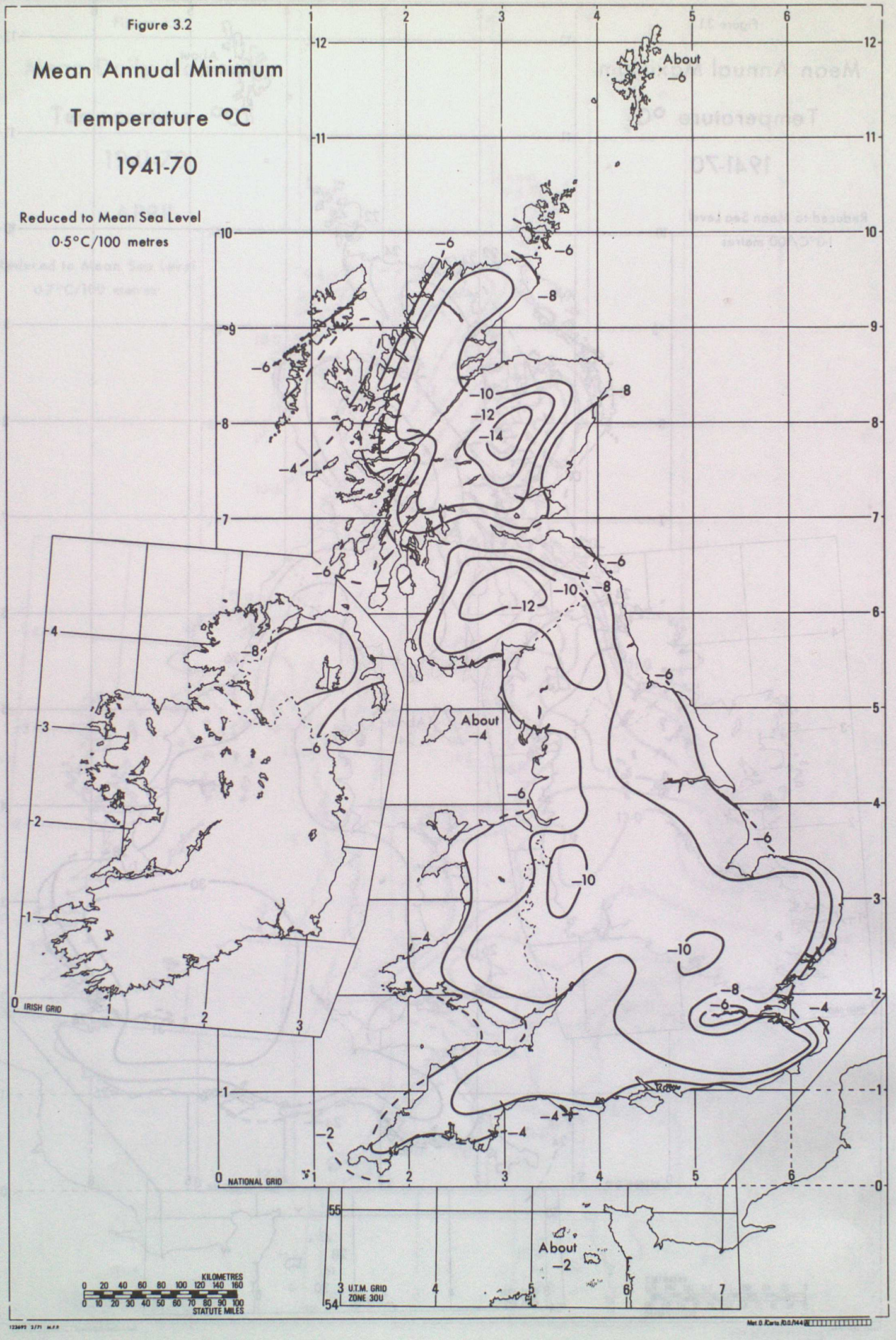


Figure 4.1

Annual Maximum Temperature oC likely to occur once in 50 years based on data for 1941-70

Reduced to Mean Sea Level
1·0°C/100 metres

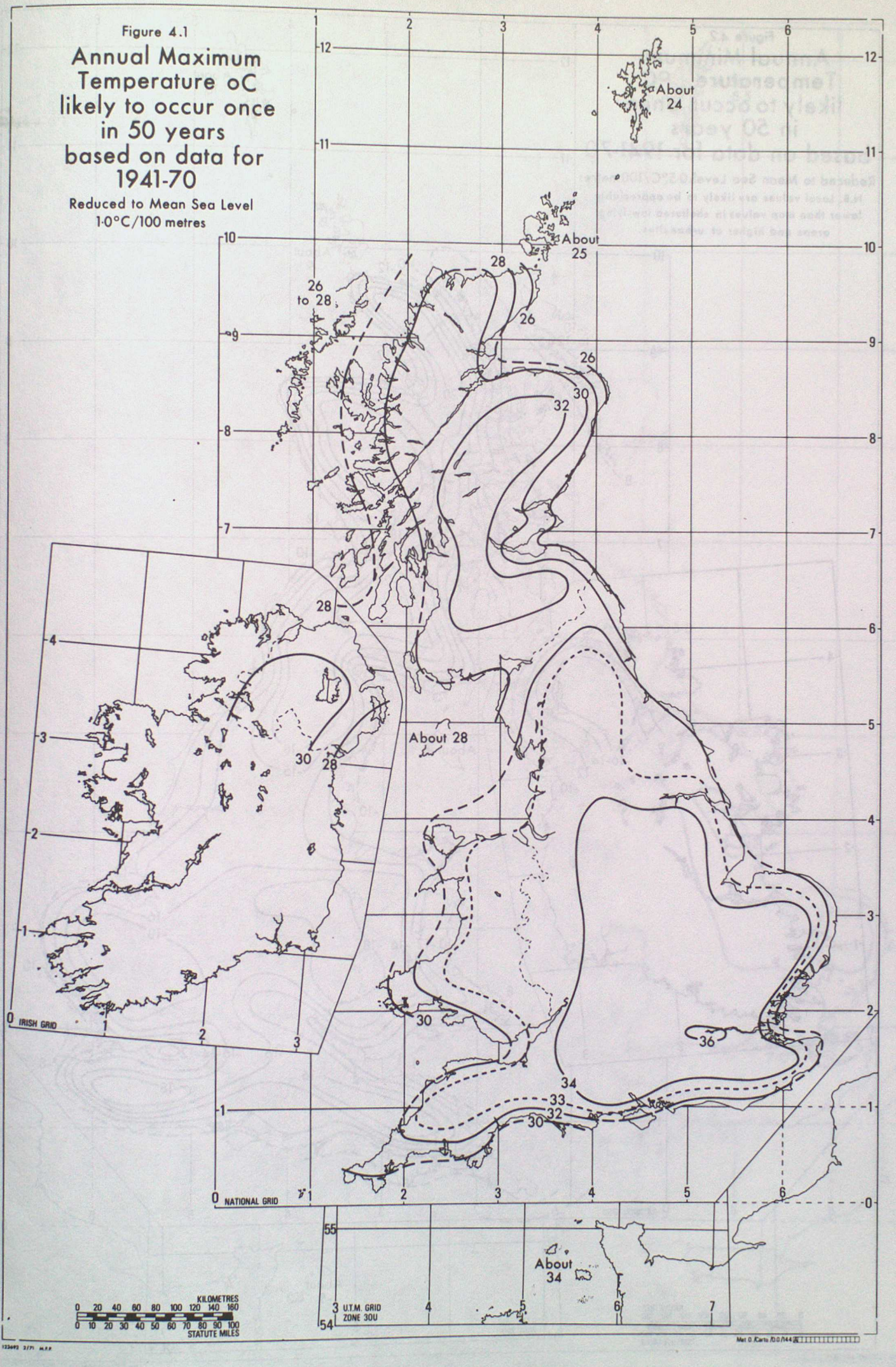


Figure 4.2

Annual Minimum Temperature °C likely to occur once in 50 years based on data for 1941-70

Reduced to Mean Sea Level: 0·5°C/100 metres

N.B. Local values are likely to be appreciably lower than map values in sheltered low-lying areas and higher at urban sites.

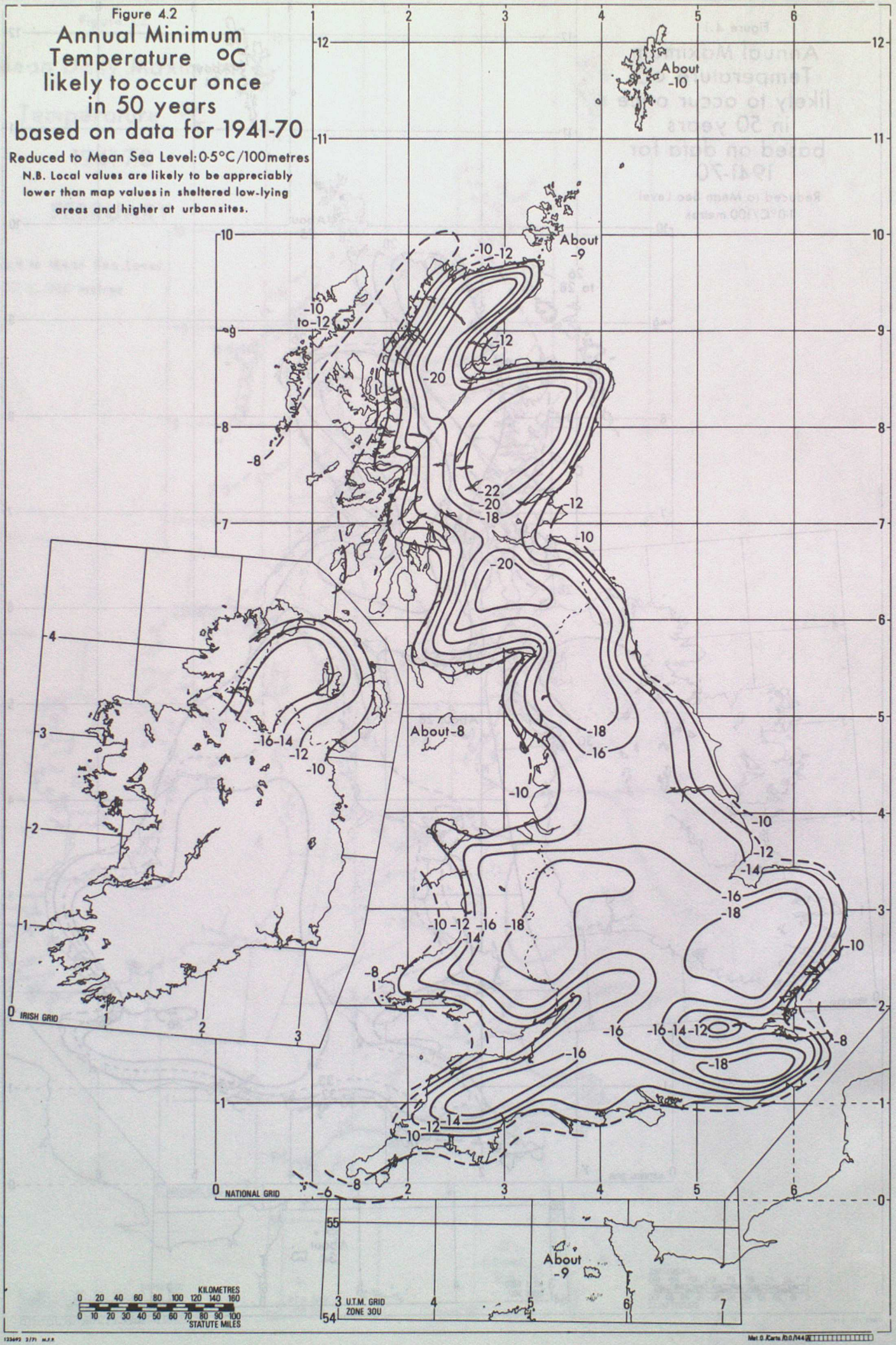


Figure 5.1

Mean Annual Number of Days with Minimum Temperature less than 0°C

1956-70

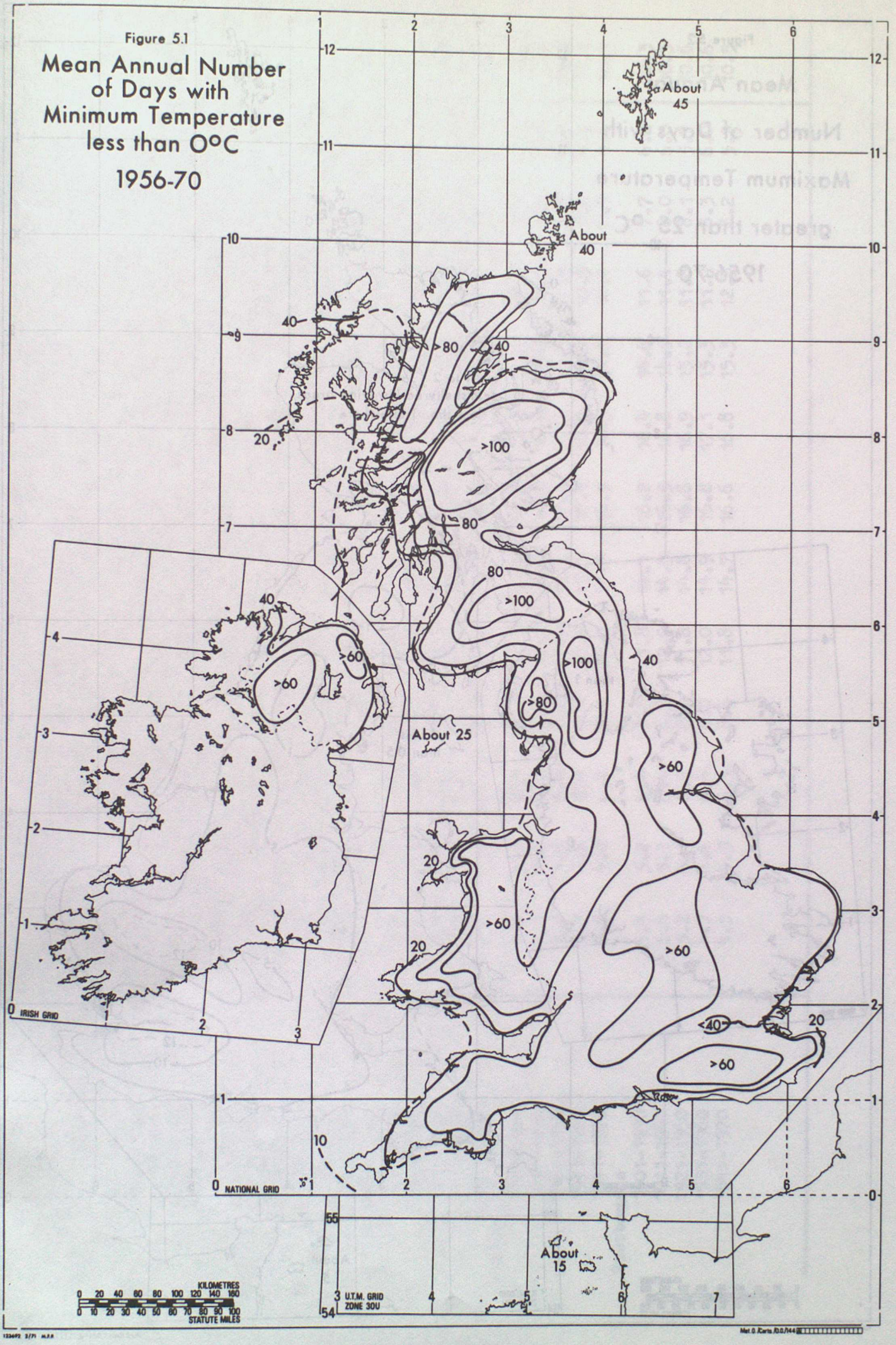
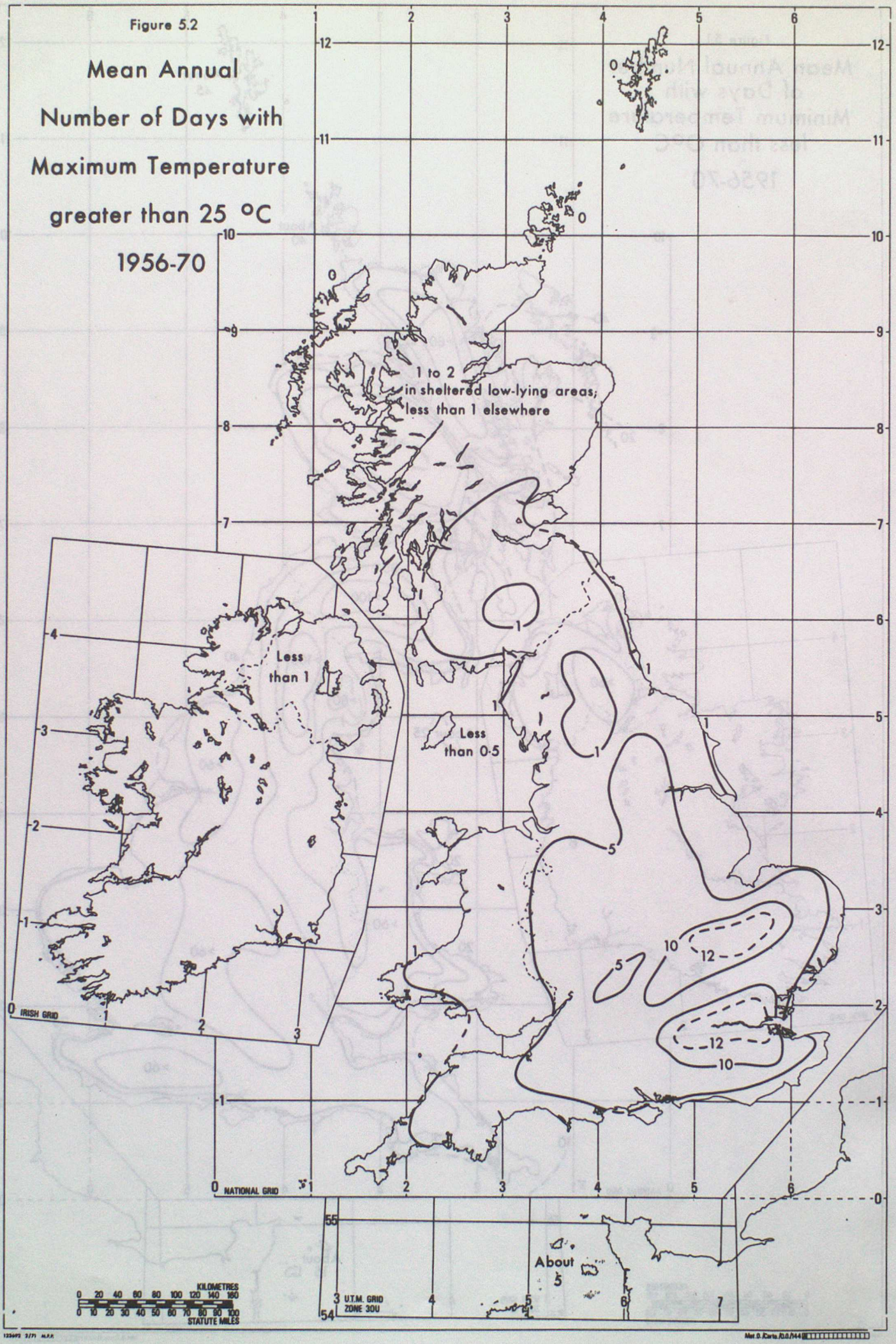


Figure 5.2

Mean Annual Number of Days with Maximum Temperature greater than 25 °C 1956-70



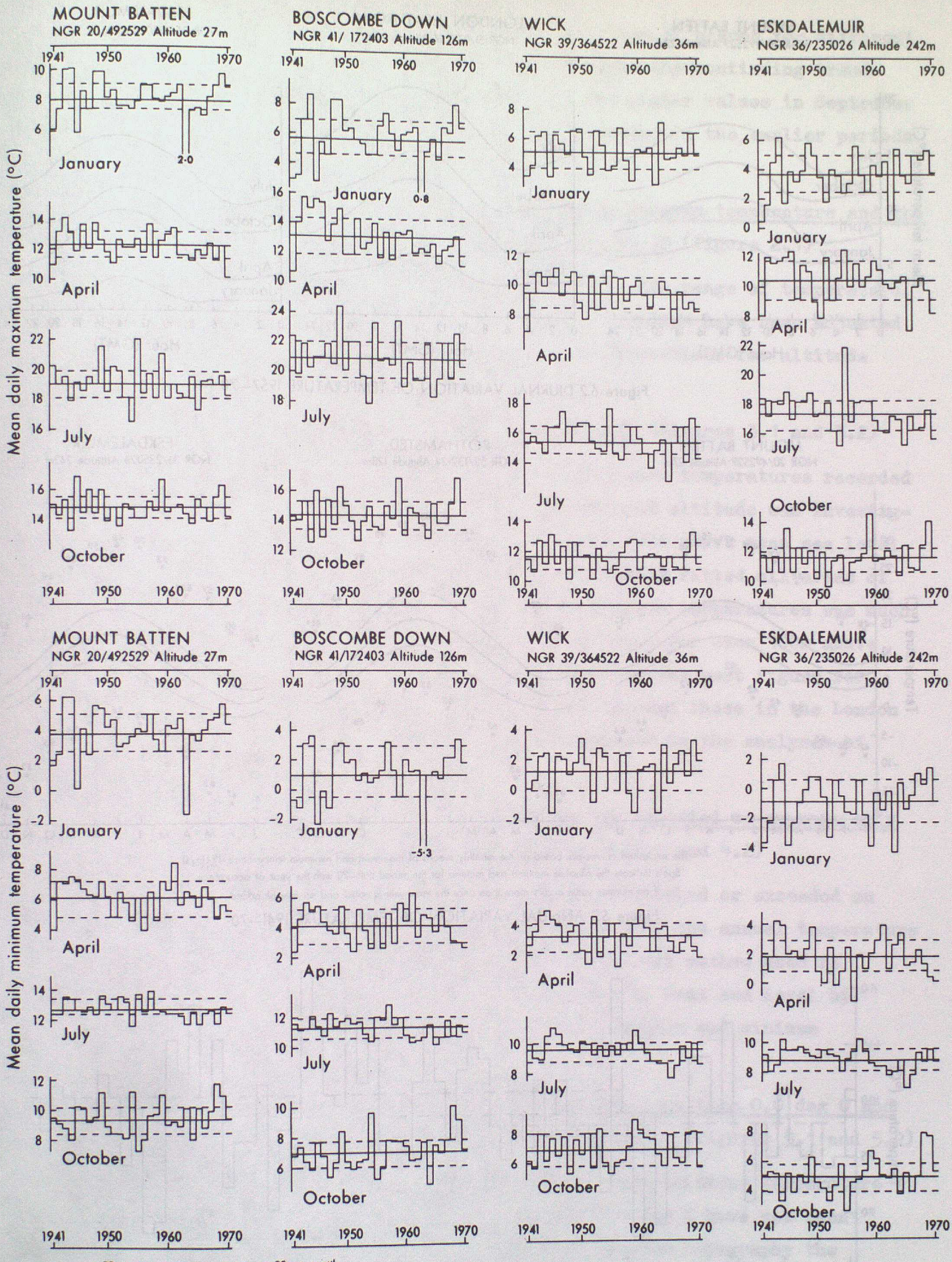


Figure 6.1 YEAR TO YEAR VARIATION OF MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURE 1941—70

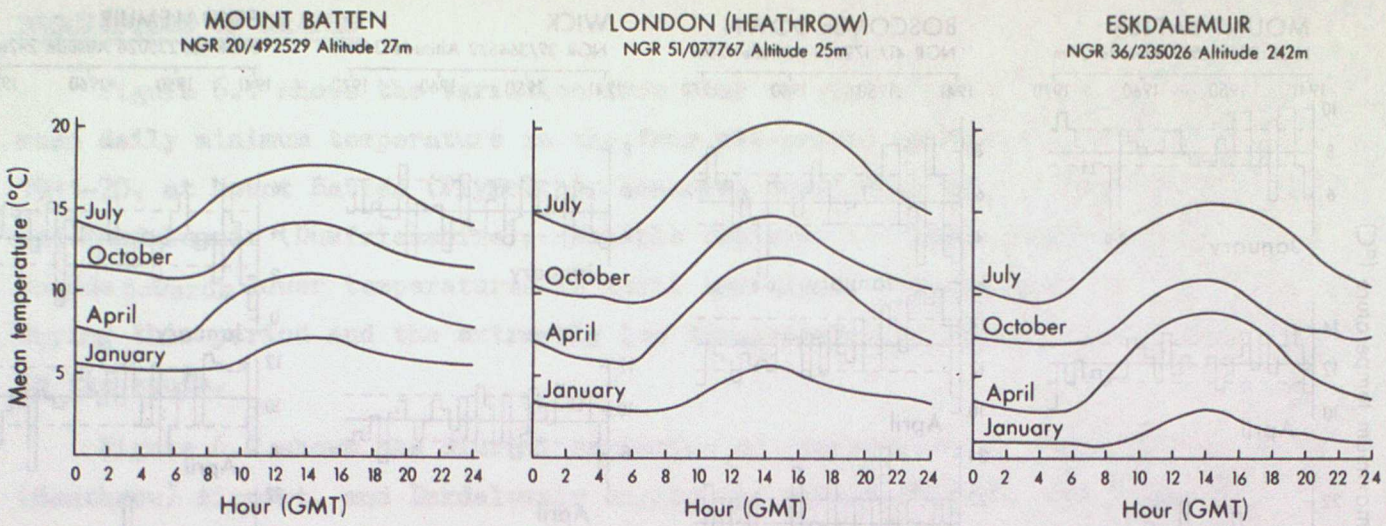
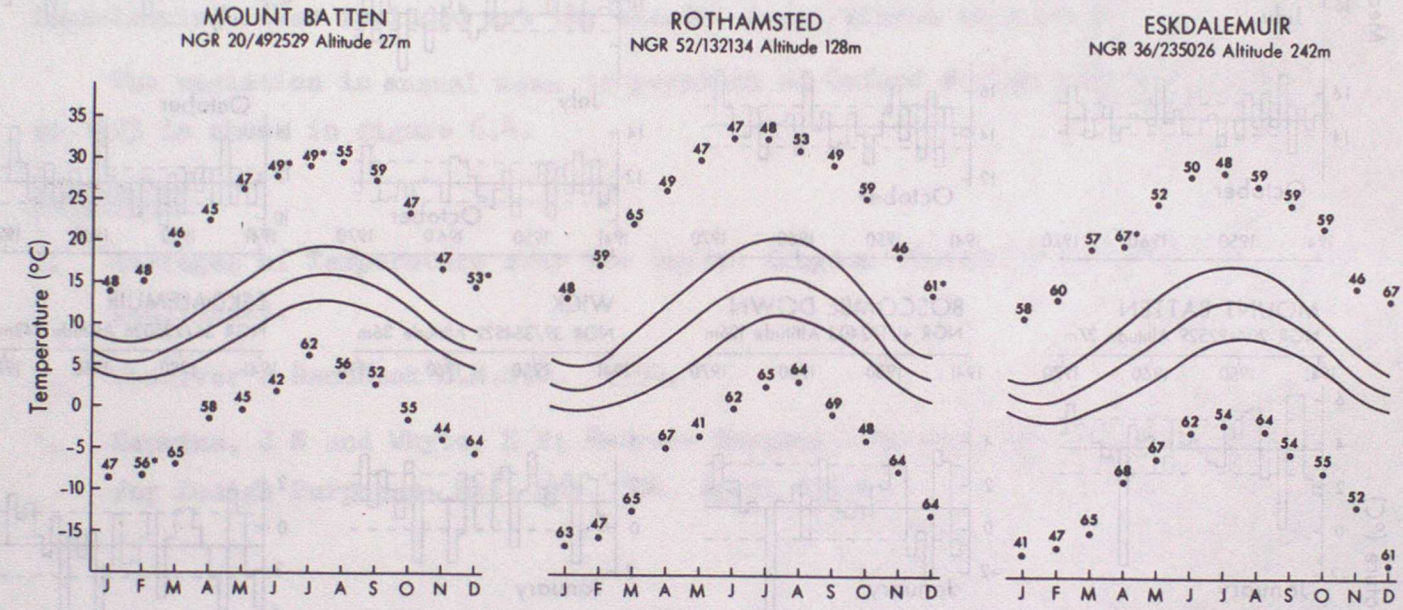


Figure 6.2 DIURNAL VARIATION OF TEMPERATURE 1957—70



The smoothed curves are based on the monthly means of maximum and minimum temperature 1941–70
Spots indicate the absolute maxima and minima for the period 1941—70 with the year of occurrence
If an extreme value occurs more than once the latest year is noted and an asterisk added

Figure 6.3 ANNUAL VARIATION OF TEMPERATURE 1941—70

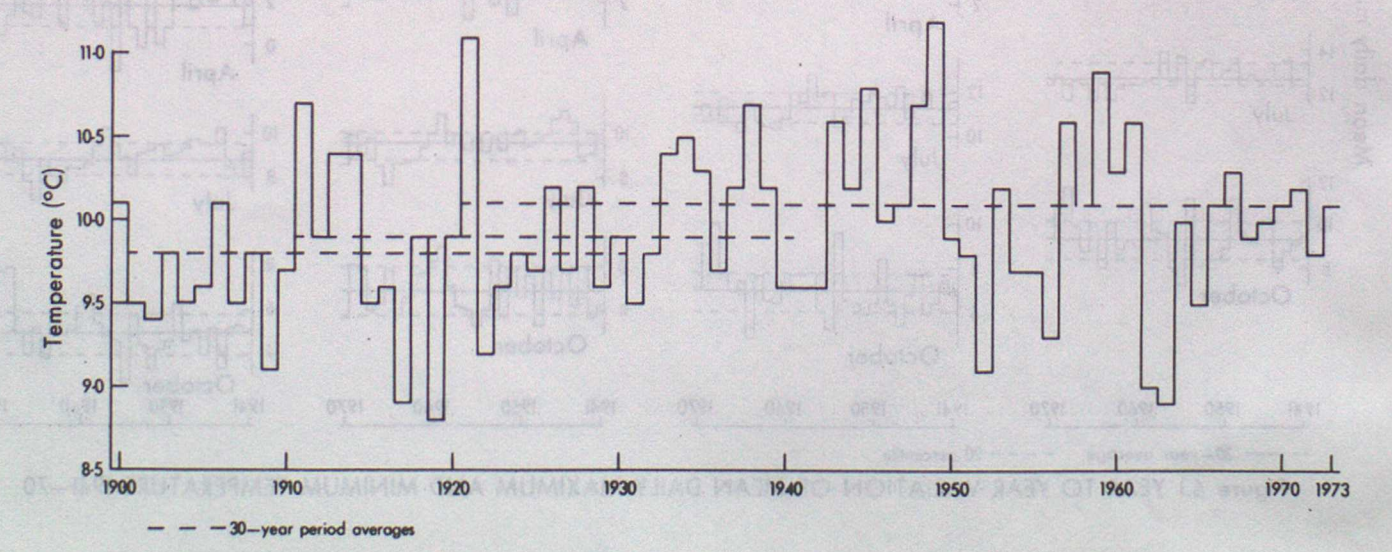


Figure 6.4 VARIATION OF ANNUAL TEMPERATURE AT OXFORD (NGR 42/509072 Altitude 63m) 1900 to 1973